Interdependence of Nature and Nurture in the Establishment and Maintenance of Mind: An Eco-Dynamic Paradigm

Dissertation presented by

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Table of Contents

Chapter 5: Perturbation Co-Equals Self-Organisation: Might Technology Co-Structure the Mind?

Chapter 6: Indo-Tibetan Buddhism: A Case Study in the Eco-Dynamic Paradigm

Declaration

This is to certify that the work I am submitting is my own and has not been submitted for another degree at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism.

Abstract

This dissertation makes the case that the human mind is established and maintained by the interdependence or enmeshment of multiple complex, dynamic systems; biological, social, and technological. These are not merely peripheral but rather, jointly are constitutive of mind. I develop this thesis in what I call the "eco-dynamic paradigm," which modifies and supplements enactivism.

This dissertation has two main theses: first, mind is established and maintained by features that draw on the resources of the brain, body and the contextual environment in which one is embedded. The second thesis is that Dynamic Systems Theory is an important resource in modelling, explaining and analysing the complex, dynamic relationships within and between scales of brain, body and contextual environment. I use the language and concepts of Dynamic Systems Theory qualitatively to describe the dynamics of brain, body, environmental relationships.

Methodologically, this dissertation is both interdisciplinary and cross-cultural. I refer to Indo-Tibetan Buddhism as an excellent example of a culture whose goal is to transform the mind to clarity by utilising a symbiotic package of meditation and visualisation practices, teachings, rituals and philosophies. These elements together provide an interconnected web which are used to support and assist the cognitive transformation of the practitioner. The conceptual and practical elements of Indo-Tibetan Buddhism, the relations between them and even the process of cognitive transformation can also be analysed by Dynamic Systems Theory.

Death and dying provide a fulcrum in which the resources of the eco-dynamic paradigm are best utilised. Indo-Tibetan Buddhist practices, concepts and philosophy related to the nature of the mind come into contrast with those of Western medical science sharply in death and dying. The challenge posed to medical science is to study and explain what might appear to be anomalous cases of alleged cognition or mental activity without brain function in near death experience. A specific programme of research is suggested in which the nature of the mind is explored neurophenomenologically.

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Chapter 1

Introduction and Overview

1.0. Introduction

Suppose that neuroscientists knew everything there was to know about neural correlates of consciousness. They knew, for example, how local neural populations scaled up to create networks with complex, dynamic, global functions. And they knew all the biochemical interactions involved in all brain functions. Would they know what consciousness *was?* In other words, if they understood the neurological and biochemical dynamics of brain function, would that be sufficient to understand how consciousness arises?

This dissertation answers that question in the negative. The first thesis of the dissertation is that human consciousness and cognition does not consist merely of brain function. Rather, the brain mediates an interdependent relationship with the body and with the environmental and socio-cultural context in which it is embedded. Of the latter, I have chosen to consider the relationship of mind with interpersonal and social relations and technology. I make the case that the interdependence or enmeshment of multiple complex, dynamic systems is what constitutes cognition and consciousness. The second thesis then is that dynamic systems theory (DST) is well suited to analyse and model cognition at multiple scales because cognition is a complex, dynamic system.

These two theses are illustrated in Indo-Tibetan Buddhism (ITB) which utilises a symbiotic collection of phenomenological cognitive technologies (PCTs) such as meditation and visualisation for the sole purpose of transforming the mind. As such, ITB serves as a case study in the philosophical framework I develop in this dissertation which I refer to as the eco-dynamic paradigm.

In the processes of dying and death there is great potential to learn about mind and mental function. In what is referred to as the near-death state when brain function has ceased, some survivors claim to have had cognitive experience. Recently, resuscitation medicine has provided such anecdotal evidence in the AWARE study. And ITB claims that one benefit of PCTs is the ability to exercise mental control of the experiential elements of death and dying. In both resuscitation medicine and ITB, cognition requires environmental embeddedness but both ITB and resuscitation medicine raise the question of what the role of body and brain is in death and dying.

1.1. Eco-Dynamic Paradigm

I use the term “eco-dynamic paradigm” to describe the framework this dissertation develops. It utilises the two features of the theses I have referred to above; namely dynamic systems theory and embodied and embedded cognition. “Eco” is the abbreviated version of “ecological”. Here I draw on the analogy of a living ecosystem in which a “homeostatic” balance must be maintained in order to remain viable. A change in one component may result in an impact upon the ecosystem as a whole to which the system must adjust. Likewise, the brain, either as a component of a system or subsystem has a domain of viability within which it must function. The brain may be perturbed by its relation with the body and environment and it may need to self-organize to maintain its domain of viability. Perturbations at any scale may possibly overwhelm the domain of viability of a system. This may be described as illness or injury from which the system may or may not adapt. Successful adaptation may be described either as recovery or chronic illness. Failure to adapt may be the equivalent of death.

There are many brain and body adaptations. Homeostasis is a complex mechanism by which critical body functions adapt. For example, when bacteria enter the body, the immune system initiates a response. T cells attack the invading organism, and body temperature in the region affected rises in response. Likewise, there are adaptive mental mechanisms. When a stressor is experienced by an individual, a complex mechanism is initiated involving the brain and several somatic systems. Neurotransmitters are released to mount a coordinated response. The result may be “fight or flight” mode. And when the stressor is no longer present, the stress response may be reversed and the multi-systemic balance may return.

Stressors may come from within the brain or body, for example, worrisome thoughts or cardiac arrhythmia, or they may originate externally. In either case, all effected systems must adapt to remain within tolerable domain of viability. We may think of the human being then as a self-organized system. In the terminology of Humberto Maturana, Francisco Varela, *et al.,* humans and all living organisms are autopoietic systems. I develop this discussion further in chapter 2.

The term "dynamic" within the eco-dynamic paradigm has two references. With regard to complex systems, "dynamic" refers to the fact these systems operate continuously, recursively and change as a function of time; time and timing must therefore be taken into account. The second reference to the term "dynamic" is that such complex systems can be modelled and explained at multiple scales of size and complexity by DST. In this dissertation, I am referring largely to the application or use of Dynamic Systems Theory that Kelso develops.

DST is a mathematical technique for describing changes in complex, dynamic systems as a function of time. Differential equations are used to express these changes. When the interaction of multiple components or processes of a system result in changes that are greater than the sum of their parts, there will not be a definite mathematical solution for the equation or set of equations. In this case, the solution is expressed as a range of possibilities. A theoretic mathematical space referred to as state space or phase space is the framework within which the range of possible states or tendencies of the system are depicted. The state of the interactions of all the components of a system at any moment may be depicted as a point in phase space. The points form a trajectory through phase space which represents a system's behaviour over time. These take the shape of what is referred to as an attractor which corresponds to a system's general behavioural tendencies or patterns, extended in time. An attractor refers to points in phase space towards which many trajectories converge that is, states to which various behaviours tend.

This dissertation takes a qualitative rather than a quantitative approach to complex, dynamic systems. I utilize the qualitative terminology of dynamical systems theory to describe the dynamics of such systems at multiples scales of magnitude and complexity. This is possible because DST is abstract; it deals with relations between components, potentially at multiple scales, rather than the specifics of the components themselves.

The human brain may be modelled and explained as a vastly complex organ, with multiple components, functions and processes operating continuously. Coordination and communication amongst its processes are necessary for its operation. And its coordination and communication with the body and the environmental context in which it is embedded at multiple scales are also necessary for cognitive function. Thus, brain-body-world may be modelled as a cognitive system of which its components are subsystems. My contention is that the human mind may be modelled as a tripartite system. And since these three components are enmeshed and operate interdependently, DST which models complex dynamic systems is the modelling tool to explain and depict these systems at multiple scales.

1.2. Enactivism

The foundation upon which the eco-dynamic paradigm is constructed is enactivism which is suited to the task (to a point) since, with this approach too, cognition is conceived as a complex brain-body-world construct. Throughout the dissertation, I draw upon enactivism but I only utilize those aspects which are useful to my purpose. To the enactivist then this might seem to be a watered down or incomplete version but it is not my purpose here to write exhaustively on enactivism. Chapter 2 discusses relevant aspects of enactivism and ancillary concepts.

The enactivist approach has constraints however which render it of limited utility for this dissertation. As a biologically based philosophical approach, enactivism has not considered death and dying as relevant to mind and cognition; or at least this has not been an enactivist concern to date. In my view, this is an omission which must be rectified. The enactivist approach as developed by Maturana, Varela and Thompson has as yet untapped resources which may be utilised in the exploration of death and dying. For example, the concept of autopoiesis as the self-organisation of living organisms is important in conceiving death as the dissolution of self-organisation. I pursue this line of reasoning in the eco-dynamic paradigm especially in chapter 7.

1.3. The Nature-Nurture Dichotomy

This dichotomy has been the subject of much controversy over a protracted period of time. This dissertation references the dichotomy of nature-nurture in relation to the establishment and maintenance of mind because it is not unusual in common parlance mistakenly to think of the genome and brain as elements of nature and interpersonal relations and technology as elements of nurture. However, I attack this misconception on two grounds. First, elements of nature, are not dynamically independent of the influence of nurture. From a dynamic perspective then, with respect to mind, nature and nurture are more an interdependent conjunct than a dichotomy. Second, from the perspective of dynamic systems theory, such dichotomies are conceived to be complementary rather than oppositional. Both aspects are thought to coexist, either as a state or as a tendency to manifest, depending upon context or conditions. For example, genes were once thought to be "informationally programmed" and deterministically expressed. Now we understand that genes express or repress function, in part, due to environmental conditions or experience. Thus "nurture" plays a large part in gene function.

As the scale expands outward, from genome to brain, to social relationship to technology, the interaction, interdependence or enmeshment between elements of "nature" and "nurture" is apparent. With respect to mind then, there is no element of pure nature or nurture.

1.4. Naturalism

The metaphysic upon which this dissertation is based is naturalism. The term has many meanings but the definition I choose to use is that naturalism refers to what exists in nature. Since science is generally agreed to be the best method to explore nature, most naturalists have embraced the scientific method as the means to explore the mind. I agree with this position but with qualification. When the subject of investigation is mind and consciousness, the traditional scientific approach presents a barrier because the third person objective stance eliminates the possibility of investigating consciousness as an irreducible first person ontology. Varela, Thompson and others who have followed them have advocated a amalgamated first person-third person methodology termed neurophenomenology. The eco-dynamic paradigm adopts this methodology. According to this approach, "objective" neural data (as measured and recorded by instrumentation) are correlated with "subjective" reports, the experiential data provided by the subject (utilising PCTs). Neither the subjective nor objective components are reducible to the other.

Notwithstanding traditional scientific concerns with the utility of subjective data, neurophenomenology prudently utilises it.

I make a distinction, in chapter 8, between metaphysical and methodological naturalism. In brief, metaphysical naturalism presupposes as a foundational assumption that reality is exhausted by physical phenomena. Methodological naturalism takes the position that the scientific method should be used to study the nature of reality and specifically the mind. As I propose to apply methodological naturalism to the study of the mind, no metaphysical position is assumed.

In chapter 9 I make a further distinction in methodological naturalism based upon the presumptions scientists and philosophers make, either implicitly or explicitly, in the study of mind. I refer to this distinction as "presumptive naturalism" and "assumptive naturalism". As I use the terms, assumptive naturalism is a stance in which the researcher assumes a metaphysical position as foundational in their research related to the mind. In contrast, presumptive naturalism asserts the position that the scientific method should be used to research the mind and is open minded as to the metaphysical position.

1.5. Methodology

Besides neurophenomenology, the eco-dynamic paradigm adopts two other methodological approaches to broaden the narrow perspective of neuroscience in the investigation of mind: The paradigm adopts interdisciplinary and cross-cultural approaches. While there is no doubt that neuroscience has provided a wealth of information about brain function, the scope of its investigation is relatively narrow. If one wishes to understand brain function in relation to bodily function and in its interaction with the world, then neuroscience alone is not sufficient. It is then necessary to investigate the embodied and embedded brain. This is an interdisciplinary endeavour, the subject matter of cognitive science. The separate disciplines composing cognitive science---neuroscience, philosophy, anthropology, computer science, psychology and linguistics---ultimately must collaborate to create a symbiotic construct of mind. This dissertation delves into four of these areas. One approach which I have adopted in this dissertation is to conceive of the separate disciplines along the lines of scale. I conceive the epigenetic component as the lowest scale involved in the establishment of mind; then the neurophysiological component (neuroplasticity); followed by the psychological component (interpersonal and social relations); and finally the societal component (technology and Indo-Tibetan Buddhism).

The cross-cultural approach is the second methodological variation adopted by the eco-dynamic paradigm. I believe that Varela *et al.* were on the right track in using this approach in *The Embodied Mind* but in my view, the value of the cross-cultural approach was not appreciated at the time and therefore was not later developed. The eco-dynamic paradigm remedies this failing particularly in the investigation of systems analysis of an "ecology of mind" (see chapter 6 discussing Indo-Tibetan Buddhism as a case history illustrating the eco-dynamic paradigm) and in research on death and dying (see chapters 7 and 8).

It is in the process of dying and death that the cross-cultural approach has the greatest potential to make headway in investigating the potential of mind. The eco-dynamic paradigm embraces this approach in the investigation of death; an original contribution to the study of mind. Because the assumptions and methodologies of contemporary science, enactivism and ITB are so different, there is the possibility for each to draw on material from the other when possible. The metaphysical foundation of traditional science is physicalism which excludes reports provided by phenomenological cognitive technologies. The metaphysical foundation of enactivism is naturalism which, in the tradition of Varela and Thompson, does not exclude the use of PCTs. The metaphysic of ITB is not easy to classify within the schema of the western philosophical tradition but suffice it to say that it denies that the ultimate nature of mind is physical. Nevertheless, ITB practitioners have utilised PCTs to hone awareness and allegedly develop cognitive capacities that would be useful to study, utilising the collective resources of both science and Indo-Tibetan Buddhism. Science and contemporary technology have developed artefactual cognitive technologies (ACTs) which may be used to study or transform the neurological function. Together these two forms of technology provide a set of complementary resources for investigating mental phenomena neurophenomenologically.

1.6. Chapter Overviews

Chapter 2 establishes the foundation of the dissertation. I consider Maturana, Varela and Thompson's view of cognition as a fundamental feature of the self-organization (autopoiesis) of living organisms. According to their life-mind continuity thesis, cognition as "skilful know how" is a basic feature of all living organisms. Therefore, the chapter initially investigates the question of what constitutes life. The view of Erwin Schrodinger that the genome is central to defining life is rejected in favour of self-organization. Features of autopoiesis are then discussed: autonomy, operational closure, and thermodynamic openness. Dynamic systems theory is introduced because it provides a schema with which the mind can be modelled at multiple scales of magnitude and complexity. I show that DST has the analytical tools necessary to model the interdependence or enmeshment, at successively expanding scales, of the epigenome and neuroplasticity (chapter 3), interpersonal and social relations (chapter 4) and technology (chapter 5).

Chapter 2 provides an example of emergence in a complex dynamic system. This is significant because DST theorizes that emergent features arise in complex, dynamic, recursive systems and some philosophers question the viability of the concept of the emergence with regard to complex mental states such as consciousness. In living organisms, the emergence of complex processes arise as a feature of autopoiesis.

Chapter 3 focuses on the interdependence of the (neural) epigenome and neural plasticity. The epigenome controls the function of the genome, expressing or repressing the manufacture of protein due to contextual experience.

I also reference the nature-nurture controversy in the context of interdependence to demonstrate that nature and nurture operate interactively. Some naively consider the genome to be an element of nature and contextual experience an element of nurture. Here we see clearly that experience influences gene function and conversely gene function influences experience. This is shown to be true not only at the scales of the neural epigenome and brain but at more expanded scales of magnitude as well. Nature and nurture are not fixed entities but rather, are contextually defined.

The nervous system is shown to be an autonomous, operationally closed system in line with Varela and Thompson's view of autopoietic systems. The brain adapts by modifying its function and possibly its structure in response to experience. DST theory is shown to be useful for modelling the dynamic by which experience impacts the brain and the neural epigenome and *vice versa.* The dynamic concept of repetitive, bi-directional feedback is relevant. Recursivity creates emergent features.

I discuss stress in this chapter as a prominent example of a perturbation that may create epigenetic and neuroplastic effects. And meditation is introduced as a means to ameliorate the effects of stress operating at these same scales.

Chapter 4 focuses on interpersonal relations as critical to the establishment and maintenance of mind. Interpersonal neurobiology (IPNB) is a dynamic approach to the development of mind in the process of interpersonal relationship. Mind is seen as an embodied and relational process, an emergent property of the body and social relationships, mediated by neurophysiological processes. The structure and function of the brain adapts to the ongoing processes. For the purposes of exegesis, I focus on caregiver-infant attachment relationship which impacts both parties at epigenetic, neurological and psychological scales. Traditional attachment theory, which is not dynamically based, is problematic. I introduce the Dynamic-Maturational Model of attachment and adaptation proposed by Patricia Crittenden, a dynamically based theory of caregiver-infant attachment.

I discuss the limbic system, specifically emotion and memory, and the impact of interpersonal and social stress. According to IPNB, emotions are dynamic processes created within socially influenced contexts. Emotion links and integrates various somatic systems to form a state of mind. Memory is a self-organising function responsive to emotional and social context.

Finally, in chapter 4, I discuss dis-integrative chronic social stress and its impact on psychological, neurological and epigenetic functions. Once again, this demonstrates the recursive bidirectional feedback suggested in the enactivist schema of cognition being a brain-body-world phenomena.

Chapter 5 focuses on the impact of artefactual cognitive technology on mind. The chapter raises the question of whether, with the development of further advances in technology we stand on the precipice of an era in which biological autopoiesis will be supplanted by technological self-organization. I consider a number of existing artefactual technologies---neurofeedback, cochlear implant, cardiac pacemaker--- and theorise what might be required to improve them so that they become sophisticated cognitive devices. Even more speculatively, I imagine a couple of further advances in technological developments---the uploaded mind and negligible senescence--- which might affect the establishment and maintenance of mind. In doing so, I demonstrate that DST can model the interaction of these technologies (either imagined or actual) on the brain.

The discussion of ACTs sets the stage for a discussion of PCTs in the next and following chapters.

Chapter 6 considers Indo-Tibetan Buddhism as an paradigm of a culture which has created an ecology of symbiotic phenomenological cognitive technologies such as meditations, visualisations, teachings, rituals, etc that constitute a package of tools designed to transform mind. At the core of ITB is the belief that the mind is plastic but that the discursive mind is conditioned to misperceive and misconceive a permanently existing Self and an independently existing plethora of phenomena. However, according to ITB, a deeper unconditioned, manifestation of mind exists which can experience all phenomena, including the Self as interdependent and impermanent. ITB practice seeks to eliminate those biasing features that inevitably cause suffering (in the Buddhist sense) in order to perceive and conceive Self and all phenomena as they are.

I discuss the concept of ignorance and how it accumulates through dynamic links of causation referred to as Dependent Origination. I also discuss a variety of concepts that support cognitive transformation: The Four Noble Truths, no-Self doctrine, two truths/realities (relative and ultimate), eightfold path, Three Jewels, impermanence, embodiment, the concept of mind, meditative practices and beliefs and practices related to death and dying. Because Indo-Tibetan Buddhism may be modelled as a dynamic complex system of practices and beliefs, the tools of DST may be utilised.

Chapter 7 considers dying and death comparatively, both from the perspective of contemporary western society (and its use of ACTs) and from the perspective of ITB (and its use of PCTs). Contemporary western society typically determines death according the whole brain/cardiopulmonary standard; a physical set of criteria. ITB conceives death as a two part process; first physical function ceases. Second, dissolution of the subtle mind proceeds. At the termination of the second dissolution, the most subtle aspect of mind remains. The contrasting theories of mind provide fertile ground to investigate mental function.

I draw a distinction between criteria of death and the concept of death and argue that the criteria of death should follow from a conception of what constitutes death. And what constitutes death should follow from what constitutes life. Since what constitutes life is autopoiesis, what constitutes death is the dissolution of self-organisation which I assert as the criterion of death. I recognise however this criterion is not without problems.

Both ITB and contemporary Western culture have recorded anecdotal evidence of mental function without brain function but additionally, ITB claims to have more convincing evidence. In the practice of the death meditation where, presumably there is no brain or body function, the region of the heart remains warm and the body shows no signs of physical deterioration, even after a prolonged period of time. And from contemporary Western society, the AWARE study of near death experience has chronicled reports by victims of mental function during the near death state. A focus on such cases, which may seem anomalous from the perspective of science and medicine, presents a challenge, either to explain these phenomena within the framework of the scientific paradigm, or to modify the paradigm to explain this data.

The phenomenology of dying and even death may be influenced by culture and the technologies that the culture makes available to those who are dying and dead. In contemporary Western culture, technology is used to keep a person alive, death being a medical failure. In ITB, PCTs are used to develop the cognitive resources to die with awareness and either to self-liberate or if possible, influence one's next rebirth.

In chapter 8, I put forward the eco-dynamic paradigm. The paradigm adopts methodological naturalism which suggests modifications to scientific methodology as previously described above and takes no ontological position on the phenomena being investigated. The focus of the paradigm is on death and dying in which seemingly anomalous data challenge the physicalist notion of mind.

The paradigm proposes specific research to investigate the nature of the most subtle aspect of mind according to ITB. Dzogchen meditation, sleep and dream yoga and the death meditation are investigated utilising both ACTs and PCTs. The hypothesis is that neurological oscillations arising from the use of all three PCTs are similar. Neurophenomenology is employed in the investigation of Dzogchen meditation and in sleep and dream yoga.

Finally, in chapter 9 of the dissertation I consider two topics: I challenge the contention that Evan Thompson, in chapter 9 of *Waking, Dreaming, Being,* attempts to incorporate death and dying into the enactivist approach. My approach is to contrast his chapter 9 with chapter 10 in which he *does* systematically incorporate "the self" into the enactivist approach.

I also further elaborate on the variety of methodological naturalism that I advocate in studying the mind. I make a distinction between presumptive naturalism and assumptive naturalism and advocate the former when a researcher investigates the dying mind from a comparative perspective. I have described each of these stances briefly in section 1.4.

It is my hope that the hypothetical neuroscientists, who know all there is to know about the neural correlates and biochemical interactions of consciousness, will be convinced that they must collaborate with other experts within the cognitive sciences to arrive at an eco-dynamic perspective on consciousness, and that they should begin cross-culturally to investigate the full potential of the mind.

Chapter 2

Enactivism: The Foundation for the Eco-Dynamic Paradigm

"Understanding the complex interplay of brain, body and world requires the tools and methods of nonlinear dynamical systems theory; traditional notions of representation and computation are inadequate; traditional decompositions of the cognitive system into inner functional subsystems or modules ('boxology') are misleading, and blind us to arguably better decompositions into dynamical systems that cut across the brain–body–world divisions."[1]

2.0. Introduction

In this chapter, I discuss a few topics that are foundational both to enactivism, a particular variety of embodied cognitive science, and to the eco-dynamic paradigm, which I develop in this dissertation. The above quotation from Andy Clark reflects commitments of embodied cognitive science. It rejects the traditional view of cognitive science that cognition is primarily a neurological function. It recognizes the inextricable link between brain, body and world that is essential in the establishment of cognition. And the embodied view of cognitive science affirms that the dynamic interplay of these three elements in the creation of cognition may be analysed by the tools and methods of dynamical systems theory. The quote also reflects foundational principles of enactivism and the eco-dynamic paradigm developed in this dissertation.

Enactivism has its roots in the work of Humberto Maturana and Francisco Varela. It is grounded in the hypothesis that all life shares common Self-organizational relationships. Thus, the question of what constitutes life was, and remains, a fundamental concern. I begin this chapter with two contrasting conceptions of life. According to the view of Maturana and Varela, Self-organization is a defining feature of living organisms and entails cognition. This is the view from which enactivism developed. Another view is that life is coextensive with the functions of a 'master molecule', now identified as DNA. Initially, I will

[1] Clark, A. (1999). An embodied cognitive science? *Trends in Cognitive Science 3(9).* 345-351. https://doi.org/10.1016/S1364-6613(99).01361-3.

consider this second view, articulated by Erwin Schrodinger, as his discussion was influential in motivating Francis Crick, James Watson and others in their molecular research. I reject this view, opting instead to focus on the view of Self-organization. Important subtopics discussed in this chapter include operational closure, thermodynamic openness, dynamic systems theory and emergence. Neurophenomenology, an important method to both enactivism and the eco-dynamic paradigm, will be discussed in chapter 3. I do not claim that this coverage exhaustively surveys enactivism. However, it does provide the basis from which I will draw in succeeding chapters.

The work of Maturana, Varela and later Evan Thompson has dovetailed with and stimulated research in several allied, inter-disciplines. Among these are Self-organisation (Kauffman[2], Luisi[3]), artificial life (Bedau[4], Boden[5]), dynamical cognitive science (Thelen and Smith[6], Kelso[7], Port and Van Gelder[8], Beer[9]). The work of Maturana, Varela and Thompson also has stimulated the expansion and elaboration of enactivism (Noe[10], Thompson[11], Hutto and Myin[12], Stewart, Gapenne, and Di Paolo[13]). However, subsequent enactivists have neglected three points. First, in my view, insufficient attention has been paid to Self-organisation within the enactivist framework. This has led to a failure to see the treasure trove available if mind is considered to be co-extensive with Self-organisation, as Maturana and Varela first proposed. Second, enactivists have not focused on the dynamic, complex

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[2] Kauffman, S. (1993). *The origins of order: Self-organization and selection in evolution.* New York: Oxford UP; Kauffman, S. (2000). *Investigations.* Oxford: Oxford UP.
[3] Luisi, P.L. (2016). *The emergence of life: From chemical origins to synthetic biology.* Cambridge: Cambridge UP.
[4] Bedau, M. (1996). The nature of life in Boden, M. (Ed.). (1996). *The philosophy of artificial life.* Oxford: Oxford UP. 332-357.
[5] Boden, M. (Ed.). (1996). Autonomy and artificiality in Boden, M. (1996). *The philosophy of artificial life.* Oxford: Oxford UP. 95-108.
[6] Thelen, E. and Smith, L. (1994). *A dynamic systems approach to the development of cognition and action.* Cambridge, Mass.: MIT Press.
[7] Kelso, J.A.S. (1995). *Dynamic patterns: The Self-organization of brain and behaviour.* Cambridge, Mass: MIT Press.; Kelso, J.A.S. and Engstrom, D. (2006). *The complementary nature.* Cambridge, Mass.: MIT Press.
[8] Port, R. and Van Gelder, T.(Eds.). (1995). *Mind as motion: Explorations in the dynamics of cognition.* Cambridge, Mass.: MIT Press.
[9] Beer, R. (1995). A dynamical systems perspective on agent-environment interaction. *Artificial Intelligence* 72. 173-215.
[10] Noe, A. (2009). *Out of our head: Why you are not your brain, and other lessons from the biology of consciousness. New York:* Hill and Wang.
[11] Thompson, E. (2007). *Mind in life.* Cambridge, Mass.: Harvard UP.
[12] Hutto, D. and Myin, E. (2017). *Evolving enactivism: Basic minds meet content*. Cambridge, Mass.: MIT Press.
[13] Stewart, J., Gapenne, O., and Di Paolo, E.(Eds.). (2010). *Enaction: Toward a new paradigm for cognitive science.* Cambridge, Mass.: MIT Press.

interplay of functional and structural scales, (micro-macro) in perception, cognition and action. Third, subsequent enactivists (with the exception of Thompson) have failed to see the value of the cross-cultural approach. This dissertation corrects these lapses.

The term 'enactivism' was popularized by Francisco Varela, Evan Thompson and Elenore Rosch in *The Embodied Mind*.[14] The book presented a view of biology, systems and mind, which has roots dating as far back as Kant.[15] The book elaborated and extended the earlier work of Humberto Maturana and Francisco Varela. According to Thompson, a protégé of Varela, enactivism theorizes that the "human mind emerges from Self-organizing processes that tightly connect brain, body and environment at multiple levels".[16] Thus, it draws on the earlier work of Maturana and Varela. Following the publication of "The Embodied Mind" and after the death of Varela, Thompson wrote *Mind in Life*. The book is rooted in the earlier work of Maturana, Varela and Thompson. It elaborates and extends the enactivist view. One thesis is the deep continuity of life and mind according to which life, in its simplest as well as most complex forms, manifests functions which, by definition, are *cognitive*. This is by no means an obvious use of the term. Some elaboration is therefore required.

In Maturana's essay, "Biology of Cognition" he says:

> "A cognitive system is a system whose organization defines a domain of interactions in which it can act with relevance to the maintenance of itself, and the process of cognition is the actual (inductive) acting or behaving in this domain. *Living systems are cognitive systems, and living as a process is the process of cognition.* This statement is valid for all organisms, with or without a nervous system."[17] (italics in the original).

This brief statement is densely packed with concepts that fundamentally change the manner in which life is defined, cognition is understood, and biological organization is conceived. Briefly, Maturana's view of cognition is that it is embedded in relations amongst components of the system and the autonomous manner in which these operate for its

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[14] Varela, F., Thompson, E., and Rosch, E. (1993). *The embodied mind.* Cambridge, Mass.: MIT Press.
[15] Juarrero, R. A. (1985). Self-organization: Kant's concept of teleology and modern chemistry. *The Review of Metaphysics* 39 (1). 107-13.
[16] Thompson, E. (2007). 37.
[17] Maturana, H. (1970). Biology of cognition in Maturana, H., and Varela, F. (1980). *Autopoiesis and cognition: The realization of the living.* Dordrecht Holland: Reidel Publishing Co. 13.

continuing Self-maintenance. I will elaborate this view in the course of this chapter. Although the view has gained traction since its initial expression, it remains a minority view in theoretical biology today. Its explanatory power has not been fully realized, I believe, even 49 years after its publication, and part of the aim of this dissertation is to illustrate how such explanatory power can be employed.

Thompson and Varela went on to develop the enactivist approach which builds on the earlier work of Maturana and Varela. The following elaborates on the quote of Maturana above and lists commitments of the enactivist approach:

> "The first idea is that living beings are autonomous agents that actively generate and maintain themselves, and thereby also enact or bring forth their own cognitive domains. The second idea is that the nervous system is an autonomous, dynamic system: It actively generates and maintains its own coherent and meaningful patterns of activity, according to its operation as a circular and re-entrant network of interacting neurons. The nervous system does not process information in the computationalist sense, but creates meaning. The third idea is that cognition is the exercise of skilful know-how in situated and embodied action. Cognitive structures and processes emerge from recurrent sensorimotor patterns of perception and action. Sensorimotor coupling between organism and environment modulates, but does not determine, the formation of endogenous, dynamic patterns of neural activity, which in turn inform sensorimotor coupling. The fourth idea is that a cognitive being's world is not a prespecified, external realm, represented internally by its brain, but a relational domain enacted or brought forth by that being's autonomous agency and mode of coupling with the environment. The fifth idea is that experience is not an epiphenomenal side issue, but central to any understanding of the mind, and needs to be investigated in a careful phenomenological manner". [18]

The fundamental shift that Maturana and Varela made was to treat living entities as autonomous agents, that is, as entities that generate and maintain themselves by virtue of their own functional and structural resources. They treated the organism as a relational unity (from its own operational perspective) rather than a group of separate components or mechanisms from the perspective of the third-party observer. They did not deny the need of the organism to couple with external environmental resources but claimed that the functional and structural integrity and the identity of the agent is maintained during and after the coupling (to the extent it remains alive[19]) as a central feature of its Self-

[18]Thompson, E. (2007). 13.

[19] See chapter 7 in which I discuss the dissolution of Self-organization as the criterion of death.

organization or autopoiesis, the term created by Maturana and Varela. The term 'autopoiesis' is important in the conceptual scheme of Maturana and Varela as it distinguishes living from non-living entities (See Section 2.2.2. for elaboration of the term). But for now, suffice it briefly to say that autopoiesis refers to Self-organizational relations amongst processes and components of a network, which regenerates itself autonomously through its processes and components. This may be contrasted with Self-organization of non-living systems, whose systems are generated and regenerated by inputs dependent upon environmental resources. An example is section Benard cells which develop in the process of Benard-Rayleigh convection. See section 2.3 for further discussion of Benard-Rayleigh convection.

Self-maintenance, as referred to in the quotation above through 'skilful know how', is what is said to be cognitive. This is not a feature of a nervous system *per se* but rather of biological Self-organization, that is, the ability of the agent, regardless of its level of complexity, to draw on its inner resources to enable it to utilize environmental resources to maintain itself. While the organism can be conceptualized as a complex, dynamic system, its coupling with the environment may also be conceived as a larger dynamic system. Dynamical Systems Theory (DST) allows for the nesting of complex, dynamic systems within larger dynamic systems and so can model this interaction. In complex, dynamic systems where interactions are recursive and circular, the linear concept of cause must give way to the more complex systems understanding of multiple interdependencies all contributing to the integrity and maintenance of the functioning organism. Again, the tools and methods of DST accommodates this complexity.

Cognition requires embodied action. It depends upon the kinds of experience that come from having a body with various sensorimotor capacities. These capacities are themselves embedded in a more encompassing biological, psychological, and cultural context.[20] Organisms interact at multiple scales[21] (including environment) such that cognitive structures and processes emerge from recurrent sensorimotor patterns of perception and action. The coupling between organism and environment modulates, but does not determine, the formation of dynamic patterns of neural activity, which in turn informs

[20] Varela, F., Thompson, E. and Rosch, E. (1991). 173-74.
[21] I use the term *scales* following Ladyman and Ross (2007)., although nothing of significance turns on this.

sensorimotor coupling. This is a dynamic, process oriented, relational view of organisms in the world. Engaged experience plays a key role. The organism is not merely a passive participant in which a pre-given world is imposed. Rather, organisms create their world and thereby meaning through their autonomy and environmental coupling at multiple scales (see section 2.3.3 for further discussion of sense-making and embodiment). In chapter 3, I discuss environmental-epigenetic coupling and contextual-neuroplastic coupling. In chapter 4, I discuss interpersonal relationship-environmental coupling and in chapter 5, I discuss technology-multiscale coupling.

This chapter fleshes out some of the commitments mentioned by Thompson. Is Self-organization a necessary and sufficient condition for the existence of life? As Prigogine has pointed out, there exist dissipative structures,[22] such as Reyleigh-Benard instability, that are Self-organizing but not alive (see section 2.3). What is the difference between living and non-living dissipative structures? The importance of this question will come into focus in chapter seven when I consider the question of what constitutes death. Next, I investigate the question of "what is life?". As I will show, the question has had a rich history with diverse views.

2.1. What is Life?

If it is true, as Thompson and I both believe, that there is deep continuity between life and mind, then it is important to consider the question of "what is life"? Three approaches have been employed in biological science to characterize life. These are complementary so more than one may be simultaneously utilized. One approach is based on genetics and reproductive populations. From this perspective, life is viewed through the lens of historical continuity and evolution, genetic links, and variations in a population due to evolutionary factors. This is the approach of molecular biology. A second approach to characterize life is ecological. Here individuals are seen as members of a population interacting with their

[22] The phrase 'dissipative structure' was coined by Ilya Prigogine and refers to structures that originate in far from equilibrium systems and in thermodynamically open conditions. Living organisms are dissipative structures as are some non-living structures.
Prigonine, I. and Stengers, I. (1985). *Order out of chaos: Man's new dialogue with nature.* London: Fontana Paperbacks.

environments. From this perspective the persistence of life depends upon integrated processes involving individuals and the environment in which they are embedded. The Gaia theory is perhaps the most extreme (though controversial) example. According to the Gaia theory, earth, its atmosphere, organisms and vegetation constitute an integrated super organism, a massive ecology. A third method employed to characterize life is to focus on a single organism and figure out what properties count as criteria for living. This approach typically generates a nonexclusive list of biological functions. Here a problem arises, as no single set of criteria has ever been identified which constitute necessary and sufficient conditions. Maturana and Varela employ this approach but with a variation.[23] Instead of taking the third person observer view in which functions are itemized, they take the organism's operational view, according to which it constitutes a functional unity. Let us take a look at a couple of introductory biology textbooks to see how they utilize these approaches.

Biology (2008)[24] is an introductory college level general biology textbook. Applying the third approach, it lists *some* properties of life but by implication downplays these as non-exclusive and not exhaustive. In other words, these are not necessary and sufficient to identify life. These properties include order, regulation, (evolutionary) adaptation, energy processing, growth and development, response to environment, and reproduction. Any non-exhaustive list of properties cannot be definitional since it does not identify necessary and sufficient conditions for life. While these properties are undoubtedly important, they may be derivative of a larger, all-encompassing definition. One might assert that a proper response to the question of "what is life" should provide an all-encompassing definition which states what is constitutive of life. In order to avoid the problem of tautology in which properties of organisms agreed in advance to be living are used in order to define what constitutes life, a theory which does not itemize properties of life must be provided. Autopoietic organization, as described by Maturana and Varela, provides such a theory. Structurally their theory is not tautological. Maturana and Varela believed they had

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[23] Thompson (2007). 96-97.

[24] Campbell, N. A., Reece, J.B. et al. (2008). *Biology.* San Francisco: Pearson Benjamin Cummings. See also Green, N.P.O., Stout, T., and Soper. (1990). *Biological Science.* Cambridge: Cambridge U.P. This elementary high school textbook lists nutrition, respiration, irritability (response to environment)., movement, excretion, reproduction and growth as observable criteria of life. It acknowledges that these characteristics exist in all living organisms to a greater or lesser extent and these are the only means of differentiating living organisms from non-living entities. 1-2.

described necessary and sufficient conditions.[25] However, others expressed doubts. For example, Bitbol and Luisi[26] believed that autopoiesis was a necessary but not a sufficient condition for life. They thought that autopoiesis was a pre-condition of cognition, that cognition is coextensive to life, but that not every autopoietic system is a living entity.[27] Bourgine and Stewart[28] believed autopoiesis was neither a necessary nor a sufficient condition of life. So Maturana and Varela's view that autopoiesis is coextensive with cognition and life is controversial.

The same biology textbook, also applying the first approach, states that evolution is the overarching theme in biology. This theory explains the unity and diversity of creatures, and the suitability of organisms to their environment.[29] The genome plays the central role here. From the evolutionary perspective, "fitness" consists of the ability of an organism to pass its genome successfully to future generations within the environmental conditions in which it is embedded. The fittest organism is that which is most successful in passing on its genome to succeeding generations. Fitness is a relative term in that it is not a property of an organism *per se* but rather of an organism embedded in a particular environmental context. For example, the brown beetle is fitter than the green beetle (colour being a phenotypical characteristic) in a brown environment because more offspring of the brown beetle survive.[30] In contrast, Maturana and Varela place autopoiesis as the central theme in biology. The relationships amongst the processes that operate within the network of the organism is the central focus.[31] The genome is relegated to a less significant position since the implementation of Self-organization, abstractly, can occur in a number of ways. Logically this makes sense as organismic Self-organization precedes its evolution. And autopoietic processes may at least partially explain why an organism is fit. Maturana ad Varela refer to evolution as a natural drift of living beings as determined by structure and

[25] "Maturana and Varela's fundamental proposition is that living systems are autopoietic or have autopoietic organization" Thompson (2007). 97. "…Autopoiesis is a necessary and sufficient condition to characterize the organization of living systems". Maturana and Varela (1980). 82.
[26] Bitbol, M. and Luisi, P. L. (2004). Autopoiesis with or without cognition: Defining life at its edge. *Journal of the Royal Society Interface.* 99-107.
[27] Benard-Rayleigh convection is a case of Self-organisation that is not a case of autopoiesis. So it is not a counter-example of the sufficiency claim of Maturana and Varela.
[28] Bourgine, P. and Stewart, J. (2004). Autopoiesis and cognition. *Artificial life* 10 (3). 327-345.
[29] Campbell *Biology* (2008). 3.
[30] *Understanding evolution: What is fitness?* https://evolution.berkeley.edu/evolibrary/article/evo_27. Accessed 5 Feb 2018.
[31] Maturana, H. and Varela, F. (1987). *The tree of knowledge.* Boston: Shambala. 94-117.

function when triggered by the perturbing agent.[32] This is a significant philosophical distinction, for Darwinian evolution is conceived as arising from and directed by conditions at least partly external to the organism while natural drift may be seen as directed endogenously, in so far as the organism maintains organizational integrity in the face of external or internal perturbations. The introduction of autopoiesis implies that the organism utilizes 'skilful know how' in adapting to perturbations and so even at the most primitive stage of life, the unicellular organism, cognition is introduced. Cognition, the 'knowing' element here describes, and is co-extensive with the autopoietic process itself. This, of course, is contrary to the manner in which cognition is traditionally conceived but avoids the problem of pinpointing when, in evolution, cognition arose. According to autopoiesis, cognition arose with the living organism and the increasing complexity of cognitive function correlates with increasing organizational complexity.

More traditionally, the biological assumption of cognition is anthropogenic[33]; it starts from the case of human cognition and is then broken down to more elementary elements or concepts. It is assumed that cognition is best explained by the elementary processes of which it is constituted. For example, cognition is traditionally explained in terms of brain function which is itself explained by neural function. Neural function in turn is explained biochemically, bioelectrically and so on. There is, however, a less traditional methodology which takes the facts of biology as the starting point of cognition and works up to the human case. This approach has been termed biogenic referring to matter, living or not, which had its origin, at least in part, in living organisms.[34] In my view, these two methodologies are complementary, not antagonistic. They derive from different methodological assumptions. The anthropogenic view assumes that human cognition provides the most useful staring point to investigate cognition. The biogenic view, on the other hand, assumes that biological organization provides the best starting point to investigate cognition because cognition is a biological phenomenon. Maturana and Varela

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[32] Ibid.

[33] *Anthropogenic* is the term used by Lyon. The term is perhaps misleading, as the starting point in the analysis of cognition, not the genesis, is anthropically based. However, I am retaining her term in describing her analysis. Lyon, P. (2004). Autopoiesis and knowing: Reflections on Maturana's biogenic explanation of cognition in *Cybernetics and Human Knowing* 11(4). 21-46.

[34] Ibid.

took the later approach, recognizing that the choice of starting point influences how cognition is described and explained.[35]

In the eco-dynamic paradigm which I am proposing, one way in which evolution may occur in organisms involves interdependent dynamical processes in which environmental perturbations interact with autopoietic processes to modify the epigenome. Although controversial, it appears that, in some cases, the resultant modification may be passed on to future generations. This will be discussed in chapter three.

Why is it philosophically significant how life is conceived? Traditionally biology has studied living entities utilizing the scientific methodology of reductionism, a top down approach. Biological structures and functions are explained in terms of their constitutive physical and chemical elements. Mental properties then are explained in terms of neural structures and processes which are, in turn, explained electrically and chemically. In contrast, Maturana and Varela took a bottom up approach, conceiving living organisms as Self-contained unities operating in reference only to themselves. Cognition is considered basic to Self-organization and scaled up in reliance on complexity and emergence. This is a non-reductionist approach according to which biological structures, processes, and systems are said to operate interdependently, creating functions, products and experiences not attributable to any single component. As organisms increase structurally and functionally in complexity, new features, which are not to be found in the simpler components, are thought to emerge. The eco-dynamic paradigm adopts the latter approach, and conceives perturbations as potentially significant co-factors in the creation of evolutionary change.

These two approaches are distinct and complementary. Adoption of the appropriate method depends, in part, upon the hypothesis being researched. Methodological reductionism is undoubtedly useful, for example, in explaining mechanisms of brain function. It has been spectacularly successful in molecular biology and neurophysiology. The success of Eric Kandel et. al. in discovering the mechanisms of long-term memory (for which he was awarded the Nobel Prize) was based on the implementation of methodological reductionism. However, this method would not be appropriate if one were

[35] There is a rough parallel in artificial intelligence. In the anthropogenic approach, a programme is modelled on a "top down" classical approach, the paradigm case being the chess playing computer. In contrast, the connectionist approach is bottom up. The paradigm here is pattern recognition. Thanks to Dr. Joel Walmsley for this insight.

investigating the dynamic processes according to which cultural context contributed to the process of learning or other situations involving multiple interactions occurring at multiple scales between brain, body and environment. In such instances, an integrative methodology such as dynamic systems science would be more useful. So, it does not necessarily follow that reducing brain function to its component biological parts is a useful functional description of how the mind is established and maintained. In my view, mind arises from multiple elements at multiple scales of size and complexity. In choosing to utilize and extend the autopoiesis framework, I am aligning with the systems approach, a nonreductive methodology, to investigate the mind.

The analysis of the origin of life cuts across methodological reductionism and systems science. The question asked by each is different. As a reductionist, Schrodinger initially framed his question in terms of the levels of physics, chemistry and biology. Before discussing Schrodinger's view, it might be useful to pause to consider the nature of reductionism. I have been referring above to methodological (also referred to as epistemological) reductionism according to which the way to *understand* an entity is to explain it in terms of the components which compose it. Strictly speaking, methodological reductionism takes no position as to the nature of what is reduced. Ontological reductionism deals with this issue. Ontological (or eliminative) reductionism is the view that the reason that reduction is the best way to understand something is because that is the way the reduced thing *actually is*. (See chapter 8 for further discussion of the methodological/ontological distinction). For example, temperature of a gas *actually is* the mean kinetic energy of its gas molecules. According to this view, language describing temperature could therefore be replaced with the language of mean kinetic energy. As described below, Schrodinger utilized methodological reductionism.

2.1. Schrodinger's View of Life

The renowned physicist Erwin Schrodinger raised the question as to "what is life"? in lectures delivered at Trinity College Dublin under the auspices of The Dublin Institute for

Advanced Studies in February, 1943.[36] His influential lectures were cited by both Watson and Crick as motivational in their search and discovery of the structure of DNA. He asked: "How can events in space and time which take place within the spatial boundary of a living organism be accounted for by physics and chemistry?" The "events" that he sought to understand were genetic regularity. His plan of attack was to answer the question first from the (biologically) naïve physicists' point of view, that is, from the laws of physics based on statistical regularity, then to compare the results of these reflections with the biological facts. Schrodinger concluded that the reflections of the biologically naïve physicist would need to be significantly amended.

A self-designated mechanist, Schrodinger believed that organismic function necessarily operated by physical laws which are orderly because they are statistical. That is, order arises at the level of the macrocosm out of disorder at the level of the microcosm. He noted that living organisms evade decay to thermodynamic equilibrium by internal metabolic processes, thus maintaining what he termed 'negative entropy'. He used the term to reflect what is apparent rather than what is in fact true. While it might appear as though metabolic processes violate the second law of thermodynamics, this is in fact not the case as 'negative entropy' is balanced by an increase in entropy in the environment of the organism.[37] He concluded that an understanding of living organisms would not be obtained through the ordinary laws of physics such as the second law of thermodynamics. In other words, laws governing living organisms could not be reduced to the statistical laws of physics. The structure of living organisms is such that new laws yet to be discovered would govern the principle by which living organisms extract order from the environment.[38] In pursuing this line of thinking, Schrodinger believed that dynamical laws were involved. His lectures coincided with the early development of cybernetics, the interdisciplinary science of control mechanisms and communication in machines and animals. Maturana and Varela were both influenced by cybernetics.[39]

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[36] Schrodinger, E. (1943). *What is life?* www.what is life.stanford.edu/LoCo_files/what-is-llife.pdf. Accessed 5 January 2016.
[37] Ibid.
[38] Ibid.
[39] Maturana and Varela (1980).

Maturana co-authored an article with Pitts, McCulloch and Lettvin, all pioneers in cybernetics, entitled "What the frog's eyes tell the frog's brain".[40] In that paper, they assumed a:

> "clearly defined cognitive situation: an objective reality external to the animal and independent of it…which it could perceive …and the animal could use the information obtained in its perception to compute a behaviour adequate to the perceived situation."[41]

As Maturana worked with animal vision over the years he eventually challenged the belief in an objective, external reality which the animal perceived and represented internally. This was required in an effort to understand some unexpected responses animals appeared to be making to various constellations of the colour spectrum. Serious consideration was given to the possibility that the activity of the nervous system was determined by the nervous system itself and not the external world. Rather than attempting to correlate the activity of the retina with the physical stimuli external to the organism, he and colleagues tried to correlate the activity of the retina with the colour response of the subject. This approach required them to treat the activity of the nervous system, as determined (in part), not by the external world but rather by the nervous system itself.[42] The nervous system had to be treated as an autonomous, organizationally closed system (although of course, interdependent with the rest of the body and structurally coupled with the environment) to account for its operation. In this manner they were successfully able to account for the response of the animal to colour. Maturana thus began to consider the nervous system as a Self-organized system triggered by external stimuli but operating autonomously.

Since autopoiesis is the launching point for Maturana and Varela's theory of cognition, a more detailed discussion of the concept must be considered.

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[40] Lettvin, J.A., Maturana, H., McCulloch, W. and Pitts, W. (1959). What the frog's eye tells the frog's brain, in Corning, W. and Balaban, M. (Eds*.).* (1968). *The mind: Biological approaches to its functions.* 233-258*.* http://jerome.lettvin.info/lettvin/Jerome/WhatTheFrogsEyeTellsTheFrogsBrain.pdf.

[41] Maturana and Varela (1980). xiv.

[42] See Maturana, H.R., Uribe, G., Frenk, S. (1968). A biological theory of relativistic colour coding in the primate retina. *Archivos De Biologia Y Medicina Experimentales (Santiago)*1(0). 1-30.

2.1.2. Autopoiesis: Self-Organization of Living Organisms

I begin with a well-known quote from Maturana and Varela describing autopoiesis:

> "An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produce them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network."[43]

The use of the term "autopoietic machine" reflected the influence of the authors' engagement with cybernetics. Its subject matter included both living organisms and non-living entities. Common to both was a focus on relationships of processes. By "machine" the authors were referring to the manner in which the operation of a system (of any entity, living or otherwise) is determined by the organization of its components. [44] The authors were not referring to an artefact whose function may be reduced to the function of its component parts, nor to any non-biological or artificial machines. They understood the operation of a machine to be mechanistic in the sense that only physical principles and forces in the physical universe are adduced. But this does not imply that the machine can be reduced to the sum of the processes of its components, for Maturana and Varela hypothesized that new properties and structures emerged from the dynamic, complex interaction of its components.

With reference to the phrase "organized (defined as a unity)": I take the language in parenthesis to clarify and amply on what is meant by "organized". A specific type of organization qualifies; a set of processes that act interdependently such that they cannot be properly understood to function except as part of a unitary system.

With reference to the phrase: "a network of processes of production (transformation and destruction) of components that produces the components", the 'organized unity' is not a unity of structures but rather of processes. The type of processes is not specifically defined; the generalization allows for a level of abstraction which is desirable in that it allows for a broad range of concrete implementations. The processes involved are relational, complex

[43] Maturana and Varela (1980). 79.
[44] Thompson (2007). 141; Maturana and Varela (1980). 75.

and dynamic; they involve the manufacture of biological components that in turn, produce other components under two conditions:

> Condition one: "through their interactions and transformations [they] continuously regenerate and realize the network of processes (relations) that produce them."

The network of processes functions recursively to maintain the processes that produce them. This is a dynamic positive feedback loop. Implied is that the autopoietic system is a network of processes in *homeostasis*. That is, as the entropy of the system increases, matter and energy flow into the system to maintain homeostasis. Homeostasis refers to a dynamic balance of vital functions, conditions and biochemistry maintained within a functional range. But as the system ages, it disintegrates and the interactions and transformations that would otherwise regenerate the network (if it were to remain in homeostasis) no longer function as well. So over time the system gains entropy, gradually loses optimal function and eventually attains equilibrium (e.g. dies). See chapter seven for further discussion of death.

> Condition 2: The processes of components produced "constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network."

The processes of components must exist within a physical space with a boundary that allows for the functioning of the network of processes. The boundary creates an outside and inside and thereby differentiates the organism from its environment. In effect it creates a 'Self' and thereby differentiates itself from the "other". (See also Thompson (2007) on cell membranes).

Maturana and Varela identified a bacterium, a single-celled organism, the least complex example of living Self-organization, as the paradigm of autopoiesis. It possesses a semi-permeable membrane that creates the boundary within which products and structures necessary for its continuing maintenance are manufactured. The membrane allows those substances to enter the cell which are necessary for ongoing maintenance of the organism and allows for the exit of metabolic waste products. It also excludes those substances unnecessary or harmful to its maintenance. And all the processes necessary for metabolism take place within the cell. In this sense it is said to be organizationally closed. The term autonomy should not be understood as meaning that the organism operates separately from its environment. Rather, it is embedded in it and necessarily draws on it for life sustaining resources, exchanging matter and energy as needed. In this sense, the autopoietic system is said to be thermodynamically open. But, according to Maturana and Varela, the environment merely creates perturbations relative to the organism to which the organism adapts based on its internal organization. While they place emphasis on the autonomy aspect of autopoiesis, they also recognize that organism and environment are structurally coupled and recursively loop, co-evolving via this feedback process. The term "system" is used to identify a set of interdependent relationships amongst the functions of the organism. Life is sustained as a result of proper functioning of these. Technically, the use of Self-organization as an indicia of life abstracts from reference to specific mechanisms of Self-organization such as DNA, RNA or those found in other carbon-based forms of life. Any entity in theory could be alive if it is Self-organizing and Self-sustaining. Thus, subsequent to the work of Maturana and Varela, a new area of research known as "artificial life" or "a-life" has flourished.[45]

The choice of bacterium as paradigm has both a strength and weakness. Its strength is that it provides the basis for Self-organization that encompasses a vast array of organisms. Its weakness, in my view, is that it excludes organisms which, some have argued, should be considered alive. Let us take the virus, for example. According to the view of the majority of biologists, it is not alive. And according to the definition of autopoiesis it does not qualify. Thompson has specified three criteria for autopoiesis consistent with the Maturana and Varela definition: The organism must: i) have a semi-permeable membrane/boundary; (ii) have a reaction network within that membrane/boundary; and (iii) conditions i and ii above must be interdependent; that is, the membrane/boundary produced by the internal network of reactions must be regenerated due to conditions created by the membrane/boundary itself. The virus meets criterion (i) as it has a protein boundary. However, it does not meet criterion (ii) as it does not have its own internal reaction network. Rather, it co-opts the network of its host and needed molecular components are produced not inside the virus but inside the host.

[45] See Langton, C.G. (Ed.). (1995). *Artificial life: An overview.* Cambridge, Mass.: MIT Press.

And it does not meet criterion (iii) because it does not meet criterion (ii). Furthermore, a virus is not self-maintaining as it draws upon the resources of its host.[46] However, the following objection to the standard criteria (which itemizes properties of life) and the autopoietic definition could be made. Rather than showing the virus is not alive (because it doesn't meet either of these criteria) it shows the weakness of these criteria, based, as it is, on what is already agreed as being alive. Recent research has suggested that some viruses and cells have a common ancient origin and evolutionary history. The assumption is that the common origin and evolutionary history provides a strong argument for considering the virus as alive.

This research was carried out by Nasir and Caetano-Anollés who utilized available protein structural and functional data to explore the evolution of the proteomic [entire set of proteins] makeup of thousands of cells and viruses. They established an ancient origin of the 'viral supergroup' and the existence of widespread episodes of horizontal transfer of genetic information between cells and viruses. Viruses harbouring different replicon [DNA or RNA molecules, or a region of DNA or RNA, that replicates from a single origin] types and infecting distantly related hosts shared many metabolic and informational protein structure domains that were also widespread in cellular proteomes. Phylogenomic analysis uncovered a universal tree of life and revealed that modern viruses reduced from the multiple ancient cells that harboured segmented RNA genomes and coexisted with the ancestors of modern cell.[47]

Arguably viral co-option of its infected host may be said to be another form of autonomy, albeit not the form of the single-celled organism. The point is not that there is a fault in autopoiesis or in the current criteria for life utilised by the majority of biologists but rather that there may not yet be any identified set of criteria which are necessary and sufficient to encompass all possible forms of life. However, even if, (assuming, for argument's sake) autopoiesis is neither necessary nor sufficient by which to encompass all possible forms of life, it is certainly sufficient for the purpose of utilizing it for this dissertation, namely, as a heuristic device to encapsulate the discussions of the interdependence of human

[46] Thompson (2007). 103-104.
[47] Nasir, A. and Caetano-Anollés, G. (2015). A phylogenomic data-driven exploration of viral origins and evolution. *Science Advances* 1(8). *doi*: 10.1126/sciadv.1500527. Accessed 23 April 2018.

epigenetics, neuroplasticity, interpersonal relations, and technology in the establishment and maintenance of mind.

Maturana and Varela distinguish between first order and second order systems.[48] Living cells are first-order autopoietic systems, whereas systems that include individual cells as structural components are second-order or metacellular, autopoietic systems. Examples of the latter include multicellular organisms, insect colonies, and human societies. Given their definition of a metacellular as any unity in whose structure we can distinguish cell aggregates in close coupling, one could also include organs, such as the heart or liver. Additionally, they believed that the nervous, endocrine, and immune systems were self-organising subsystems of the multicellular. In chapter three, I focus mainly on the nervous system as a multicellular, self-organising system.

According to Maturana and Varela, what distinguishes living systems from non-living systems is the self-determining, self-maintaining or autonomous nature of the former. An autopoietic system maintains itself only in accordance with its internal, self-producing organization. There is a critical difference between self-organization and self-maintenance. self-organization broadly refers to the relations amongst the processes of a system that, taken together, constitute its unitary nature. It may occur either in living or non-living systems. In living organisms, it manifests in a specific way, as described by the term autopoiesis. Examples of self-organizing systems that are not autopoietic are tornadoes and the hydrologic cycle. Self-maintenance, on the other hand, refers to self-producing organization of a living organism and requires relationships amongst its processes directed with "skilful know how" or cognition.

In contrast to the living system which exhibits operational closure, the non-living system is operationally open, controlled by and dependent upon external input. The paradigm of the latter is a conventional desktop computer which requires input and internal processing instructions from outside the system.

[48] Thompson (2007). 105 citing Maturana and Varel (1987). 87-89.

2.1.2.1. Operational Closure

According to Moreno and Mossio:

> "A domain k has closure if all its operations defined in it remain within the same domain. The operation of a system has closure therefore if the results of its action remain within the system."[49]

Closure of *processes* is a fundamental invariant of autopoietic organisms according to Maturana and Varela. It is consistent with thermodynamic openness (see 2.1.2.2). For example, it might be argued that closure of processes is violated when organisms excrete waste products, but this is not the case. Excretion of waste products is a feature of thermodynamic openness in which matter and energy is exchanged between organism and environment.

Moreno and Mossio have argued that even if closure of processes is invariant of autopoietic systems, it does not alone specify living systems as autopoietic. It may also be seen in autonomous non-living entities as well. The additional qualification that in biological entities closure occurs within specially localized bounds does not sufficiently distinguish living from non-living autopoietic systems. They have argued that the hydrologic cycle is composed of closed processes and could arguably be said to operate within spatially localized (although extended) bounds. The hydrological cycle describes the circulation of water in nature. It begins with the evaporation of water from the surface of the ocean. As moist air is lifted, it cools and water vapor condenses to form clouds. Moisture is transported around the globe until it returns to the surface as precipitation. Once the water reaches the ground, one of two processes may occur; either some of the water evaporates back into the atmosphere or the water penetrates the surface and becomes groundwater. Then, groundwater either seeps into the oceans, rivers, and streams, or is released back into the atmosphere. The balance of water that remains on the earth's surface is runoff, which empties into lakes, rivers and streams and is carried back to the oceans, where the cycle begins again.[50]

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[49] Moreno, A. and Mossio, M. (2015). *Biological autonomy.* Dordrecht: Springer 3 citing Bourgine and Varela (1992). xii.
[50] *A summary of the hydrologic cycle.* http://ww2010.atmos.uiuc.edu/(Gh)./guides/mtr/hyd/smry.rxml. Accessed 9 February 2018.

I believe that Moreno and Mossio are correct in recognizing that organizational closure may occur in non-biological systems but that is not inconsistent with the view that closure is an invariant of biological systems. Rather, they have only shown that it is not a *sufficient* criterion for biological systems.

Again, Moreno and Mossio have argued that the autopoietic conception of closure fails to recognize the proper level of causation at which closure operates. They say it's not at the level of processes that it operates but rather at the level of constraints. Closure consists of:

> "local and contingent causes exerted by specific structures or processes which reduce the degrees of freedom of the system on which they act… [it] consists of a specific kind of mutual dependence between sets of entities…"[51]

This objection I take to be more serious but not fatal. Again, they have not showed Maturana and Varela to be incorrect. Closure of constraints at a higher scale does not obviate closure of processes at a lower scale. Biological closure operates at two different scales; at the scale of processes and, at a higher scale, as constraints imposed on lower scale processes (so called "downward causation").[52] Consider, for example, the stress response, consisting of a cascade of biological processes. This response operates automatically at a lower scale. At a higher scale, the stress response may be constrained by consciously utilised techniques such as deep breathing, visualisation and meditation.

2.1.2.2. Thermodynamic Openness

The autopoietic organism is a dissipative mechanism which, one might incorrectly think, violates the second law of thermodynamics in that it manages to maintain homeostasis far from equilibrium. It does this by extracting "order from order" (as Schrodinger would have said), that is, extracting from ordered elements of the environment (e.g. food) that which is necessary to continue Self-maintenance. Prigogine referred to a system (including an

[51] Moreno, A. and Mossio, M. (2015). 6-7.

[52] Note that downward causation in the biological context as constraint is different from Kim's take on downward causation in which higher level mental properties (which are distinct from biological, physical or chemical processes) act on lower level (physical) processes.
See Kim (1992). Downward causation in emergentism and nonreductive physicalism in Beckermann, A., Flohr, H., and Kim, J.(Eds.). (1992). *Emergence or Reduction*. Berlin; New York:. deGruyter.

organism) far from equilibrium as a dissipative structure in so far as it achieves this result by the exchange of energy and matter with the environment. Operation of living organisms far from equilibrium does not violate the second law of thermodynamics. The organism maintains homeostasis by increasing the entropy in the environment. Its thermodynamically open structure provides the means by which this dynamic process is achieved. It can be modelled by dynamic systems theory.

There is no conflict or inconsistency in the notions that a living organism may be operationally closed but thermodynamically open. The relationship between the two concepts may be conceived as follows. As an operationally closed system the focus is on system function and influences outside the system are regarded as perturbations to be accommodated within the parameters of structure and function to the extent that this is possible. In these considerations primacy (of a sort) is given to the closed operation of the system. On the other hand, as a thermodynamically open system, primacy is given to the fact that the exchange of energy and material are vital to the maintenance of the system. Organisms which are operationally closed and thermodynamically open are necessarily structurally coupled with the environment in which it is embedded. Systems are coupled when the conduct of each is a function of the conduct of the other; in dynamic systems terms, when the state variables in one system are parameters of the other and vice versa.[53] So a system may be either coupled with the environment or decoupled and depending upon explanatory interests one or the other may be prioritised. Maturana and Varela used the term "*structural coupling*" to refer to the history of recurrent reciprocal interactions of two or more systems leading to their structural convergence.[54] While both thermodynamic openness and operational closure simultaneously apply, theories (such as autopoiesis or Darwinian evolution) tend to emphasize either operational closure or thermodynamically openness, respectively. The eco-dynamic model considers operational closure and thermodynamic openness as interdependent features in the establishment and maintenance of the living organism. The mechanism of homeostasis demonstrates this interdependence.

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[53] Maturana and Varela (1987). 45.
[54] Ibid.75.

Homeostasis, often referred to as 'stability through consistency', is fundamental to autopoiesis. It is a vital mechanism of Self-maintenance. The concept has been important in physiology and medicine since Claude Bernard who declared:

> "All the vital mechanisms …have only one object---to preserve constant the conditions of…the internal environment."[55]

The term itself was coined by the physiologist Walter Cannon. This has been understood to mean that the purpose of physiological regulation is to establish and maintain a "set point" that is, a specific numerical value for each internal parameter by sensing deviations from it and correcting it through negative feedback.[56] The term is still used to describe the stabilizing feature of organismic function even though it has been recognized for some time that there is no single optimal level for any somatic function. Rather, physiological functions vary in response to one's physical and mental activity and the conditions of the environment. The term '*allostasis*' has been introduced by Sterling and Eyer in the 1970's and refers to physiological mechanisms that create stability through change. Both concepts share the understanding that stability of core internal functions operate through dynamic feedback loops although they differ as to the nature of the loops. It was Sterling and Eyer's view that the term allostasis should replace homeostasis.[57]

In the allostasis model, blood pressure (BP), for example, is modulated by predicting what level will be needed at a given time based upon circumstance and overriding local feedback to meet anticipated need. In contrast, according to the homeostasis model the set point would be fixed and significant deviations from it would be considered pathological. But in the case of hypertension, the homeostasis model is inadequate since it assumes

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[55] Sterling, P. (2004). Principles of allostasis: Optimal design, predictive regulation, pathophysiology and rational therapeutics. In Schulkin, J. *Allostasis, homeostasis and the costs of adaptation.* Cambridge: Cambridge U.P. http://retina.anatomy.upenn.edu/pdfiles/6277.pdf. Accessed 29 July 2016.

[56] Ibid.

[57] Some researchers use the term allostasis to refer to systems that need to adapt within broad boundaries and homeostasis to refer to systems that need to adapt within narrow boundaries. McEwan, B.S. (1998). Protective and damaging effects of stress mediators. *New England Journal of Medicine* 338(3). 171-179. http://gettingstronger.org/wp-content/uploads/2011/07/McEwen-1998-Protective-and-Damaging-Effects-of-Stress-Mediators.pdf. Accessed 28 July 2016.
I believe the view of Sterling and Eyer is preferable. In normal circumstances, all physiological parameters, adapt with the range that is dynamically appropriate. In my view, the degree of variability should not be determinative as to the given name.

hypertension as such is pathological. This may or may not be the case, depending upon contextual circumstances.

In contrast, the allostasis model considers hypertension as an adaptation due to stress such as a difficult life circumstance (social marginalization, for example) or in the case of children, increased stress (due to parental separation, for instance).[58] According to this model, high BP is a successful short-term solution by an organism to increase vigilance, although dangerous in the long-term. In this illustration, both allostasis and autopoiesis consider the organism as adapting its organization in response to environmental contingencies. And both focus on the dynamic nature of organismic organization. But, in my view, the allostasis model shares with the eco-dynamic paradigm the recognition that external contingencies and organismic Self-organization are co-dependent and may co-evolve. In the case of hypertension for example, the allostasis model and eco-dynamic paradigm both recognize that hypertension is merely a symptom, an adaptation to stress. Sterling points out that salt (NaCl) does not raise blood pressure; rather, stress does. By this he means that stress is the precipitating cause of the desire for salt. Salt provides the mechanism and satisfies a societal need to raise blood pressure as an adaptation to increased social stress. Wittily, Sterling points out that if food manufacturers did not add salt to food, the public would demand the equivalent to a public salt lick. If he is correct, it would be fair to say that societal demands such as increased productivity, for example, experienced as stress by many individuals, co-structure organismic Self-organisation. In this case, societal expectation is the cause of primary hypertension, intake of salt is the response. The concept of allostasis conceives a broader causal framework than that of homeostasis. According to the allostasis model, societal and individual solutions may be required to modulate chronic stress. The allostatic model recognizes this co-dependence of multiple scales. This model is useful to understand the interdependence of multiple factors at multiple scales in the establishment and maintenance of mind. Furthermore, it is useful in reconceiving the way in which relationships between factors may be methodologically significant.

[58] This is the view of Sterling and Eyer. Perhaps the fact that they are both social activists has contributed to this view. McEwen (1998) believes that individual responses to stress is largely determined by one's perception of the stressor and one's general state of health. There is no contradiction between the two as the former is considering stress as a social phenomenon whereas the latter is considering its effect on the individual.

In my view, whether one uses the terms homeostasis or allostasis perhaps depends upon context. For policymakers, sources of societal stress and its impact on society might have primacy due to the nature of their focus on social policy. In this instance, the term 'allostasis' might be more useful. But for medical practitioners whose concern is their patients' vulnerability to stress and its impact on their mental and physical well-being, the term "homeostasis" may be more useful.

The allostasis model is committed to six interrelated principles three of which are particularly relevant in light of dynamical systems theory. First, organisms design for efficiency. Natural selection, as moulded and refined by autopoiesis, shape every physiological system to meet only the maximum needs likely to be encountered plus a minimal safety factor. No system is overdesigned as this would create energy waste and inefficiency. It might be argued that this claim cannot be justified by evidence that natural selection has allowed for the creation of redundancy in many cases. To this the advocate of allostasis might respond that redundancy in an organ or organism is in fact efficient if one considers the environmental context in which it developed. He might cite as an example of the efficiency of multiple redundancy, the human brain which creates many possible pathways for the instantiation of any particular cognitive state. The redundancy is efficient because it allows for the possibility of continuous function in the instance of brain injury. Likewise, so called vestigial biological structures may not an example of biological inefficiency. For example, the appendix has long been thought to be a useless evolutionary artefact. But this belief may be due to our ignorance as to its function. Now there is some evidence that it serves as a storehouse of good bacteria.[59]

While the principle of allostasis as stated by Sterling might appear to give priority to natural selection over autopoiesis in shaping organismic function and suggest that natural selection is teleological, neither are the case. The main point here is efficiency of the organism and not the cause or source of the efficiency.

Second, efficiency requires reciprocal trade-offs, that is, the sharing of energy resources as needed. Organs can make short-term energy 'loans' as needed. For example, when skeletal muscle is at peak effort (about 90% of peak cardiac output) cardiac output alone is

[59] Duke University Medical Center (2009, August 21). Evolution Of the human appendix: A biological 'remnant' no more. *Science Daily*. Accessed 2 December 2019 from: www.sciencedaily.com/releases/2009/08/090820175901.html.

an insufficient blood supply. In such a case, renal and splanchnic circulations contribute blood and their cardiac output drops from about 20% to about 1%. Autopoiesis too recognizes the interdependence of multiple systemic resources in organismal function.

Third, these reciprocal trade-offs require a central control mechanism to monitor and coordinate functions while enforcing a specific hierarchy of priorities. This mechanism is the brain. So, for example, if muscular effort is great but one has just eaten and it is warm, the brain triggers the vomiting reflex. Feedback loops play a vital role in this situation.

The allostatic model recognizes the significance of the role of the organism's autopoietic function. For example, the autonomic nervous system interacts interdependently and dynamically with somatic function. Circular feedback provides the mechanism according to which both operate seamlessly.

2.2. Dynamic Systems Theory[60]

It is my contention that dynamic and dynamical systems theory provide sound theoretical frameworks to describe the establishment and maintenance of mind at multiple scales. My focus is on the qualitative rather than quantitative description of complex systems. In this section, I will discuss important aspects of Dynamic Systems Theory (DST) relevant to this dissertation. In the next chapter, epigenetic and neuroplastic effects will be shown to be linked in a manner well described and modelled by DST. Likewise, in chapter 4, interpersonal and social relations will be shown to be linked with mind in a manner well described modelled by DST. And in chapter 5, technological artefacts will be shown to be linked with mind in a manner well described and modelled by DST. And each scale interacts with others in a manner that, in principle, can be described using the qualitative concepts of dynamic systems-- control and variable parameters, trajectories, attractors, state space, phase portraits, dynamic instability, metastability, coordination dynamics--and not the quantitative tools of differential equations. Likewise, instantiations of concepts associated

[60] I distinguish between dynamic systems theory and dynamical systems theory. The central tenet of the former is that "order, discontinuities and new forms emerge precisely from the complex interactions of many heterogeneous forces." Thelen and Smith (1995). *A dynamic systems approach to the development of cognition and action.* Cambridge, Mass: MIT Press.
The latter is a mathematical approach to the description and analysis of complex dynamic systems utilizing differential equations.

with enactivism such as autopoiesis, interdependence, and circular causality may be modelled and explained by DST.

According to Van Gelder, the dynamical hypothesis in cognitive science can be stated very simply; cognitive agents are dynamical systems. This can be understood either ontologically ("cognitive agents *are* dynamical systems") or epistemologically ("cognitive agents can be *understood* dynamically"). I apply the hypothesis epistemologically. Van Gelder contrasts the hypothesis with the prevailing view, the computational hypothesis, that cognitive agents are digital computers.[61] It is not my purpose to defend the dynamical hypothesis as against the computationalist hypothesis. In adopting the epistemological view of dynamic systems, I am taking the position that DST is an excellent tool to describe the establishment and maintenance of mind at multiple scales and this view will be exemplified in each chapter. It is worth noting that Van Gelder did not explicitly apply DST to systems across multiple scales.

The term "dynamic system" requires some discussion. There is no single definition of this term nor has there yet been clarity as to how all the properties of dynamic systems interrelate. According to Van Gelder:

> "Dynamical Systems Theory … is a branch of pure mathematics. Its domain extends to any kind of describable change, but it focuses attention particularly on systems for which there is no known way to specify behaviours as functions of time (e.g., systems whose rule is a set of nonlinear differential equations with no solutions). The fundamental move is to conceptualize systems geometrically, i.e., in terms of positions, distances, regions, and paths in a space of possible states. Dynamical Systems Theory aims to understand structural properties of the flow, i.e., the entire range of possible paths."[62] (emphasis added).

Dynamical Systems Theory may be utilized at multiple scales to describe functional relationships where change is ongoing, as it is in some non-living systems and of course, all living organisms. A classic example of a dynamic system which is describable by DST is Reyleigh-Benard instability,[63] which describes a far from equilibrium system in which

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[61] Van Gelder, T. (1998). The dynamical hypothesis in cognitive science. *The Behavioural and Brain Sciences* 21(5). 615-28.
[62] Ibid.
[63] Ma, T. and Wang, S. Rayleigh-Benard convection: dynamics and structure in the physical space. https://arxiv.org/pdf/math/0611316.pdf. Accessed 9 July 2018.

external influences are introduced that cause the system to move initially from a condition of chaos to order. The phenomenon is demonstrated in the following example. A pan of water is heated from underneath and cooled from above. A temperature gradient arises between the top and bottom layers of water. When the gradient reaches a threshold, referred to as a bifurcation point, the water '*Self-organizes'* into hexagonal convection cells, a collective effect. Temperature is the control parameter. Random movement of microscopic molecules then become organized macroscopically. This may be conceived as "top-down causation". Microscopic perturbations of the initial conditions are enough to produce a non-deterministic macroscopic effect.

That is, in principle, there is no way to calculate the macroscopic effect of a microscopic perturbation. This inability to predict long-range conditions and sensitivity to initial conditions are characteristics of complex, dynamic systems.[64] See section 2.4. for further discussion of this phenomenon as related to emergence.

Dynamic Systems Theory has infiltrated deeply into several sciences, social sciences and humanities. The systems conceptual framework forms the basis of systems biology, an integrative (rather than reductionistic) approach to biology. It is the opinion of Boogerd et al. (2007) that the current mainstream philosophy of biology is inadequate due to its failure to take systems thinking into account. The stinging indictment of the current state of philosophy of biology is extreme and may not be fully accurate, but it makes its point bluntly:

> "Philosophy of biology is … concerned with a biology which is descriptive rather than predictive, a biology which asserts that an understanding of the living world will come from descriptions of the histories of organisms, in particular their genetic history, and from a catalogue of the molecules of which organisms are composed. …Indeed, the existing philosophy of biology fails to address the rather profound issue of what distinguishes the living from the non-living, except to say that something lives because its ancestors lived. In its current state, the philosophy of biology does not have the wherewithal to consider a single organism as an integrated, functionally organized system that can be understood *per se*, independent of its evolutionary history…. Only systems biology takes up the challenge of understanding living organisms as wholes, in terms of integrals of their interacting and organizing constituents. It aims to predict systemic behaviour of

[64] See Prigogine, I. and Stengers, I. (1984). See also Kelso (1995). 6-8.

organisms from their constituent processes... This surely has profound philosophical implications for biology as a whole."[65]

This quotation may be controversial yet makes a point worth raising. First, the controversial aspect. The fact that biology is descriptive rather than predictive is not a weakness of biology *per se*. Rather it is one methodological approach to the definition of life which does not exclude others. It has been quite both useful and successful in categorizing a large variety of organisms. As we saw in the discussion of viruses (section 2.1.2), the common origin of some viruses and single cells provides some evidence and an argument that viruses are alive. Evolutionary and reductive descriptions are useful for a variety of purposes but have their limitations. One such limitation, as mentioned in the quote above, is that the descriptive method does not illuminate a most significant aspect of biological organisms, namely their dynamic function as unities. Operating at multiple scales, organisms integrate and unify structure and function at several scales of description. DST provides a framework within which the merger of these scales may take place. In order to understand the organization of an organism, it is not sufficient to understand its component parts. One must understand the coordination of those parts in relation to the whole and the constraints of the whole upon the parts. This was the position taken by Maturana and Varela. They conceived that "the dynamics of interactions and transformations which [a machine] may undergo as a unity constitutes its organization".[66] The relationships of the components constitute its organization. The relations among *specific* components of a concrete system which constitute it as a unity are referred to as its structure. For example, an automobile as a unity is specified by the interactions amongst its various components. The components themselves may take various forms. For example, the engine may be fuelled by petrol or diesel, etc. What matters in constituting an automobile is e.g. the relation of the engine to the other components.

Dynamical Systems Theory may be applied to create mathematical models to describe and predict the behavioural tendencies of specific systems to change over time. Specific parameters are designated as significant and represented as quantitative variables. The values of the numerical variables of all the parameters at any one time represent the state

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[65] Boogerd, F.C., Bruggeman, F.J., Hofmeyr, J.H.S. and Westerhoff, H.V (Eds.). (2007). *Systems biology: Philosophical foundations.* Amsterdam: Elsevier 9.
[66] Maturana and Varela (1980). 77.

of the system at that time. The space (one dimension per variable) of all possible states of the system as it changes over time is referred to as 'state-space' or 'phase-space'. A dynamical system model provides one or more equations for determining the location of a point or path of a trajectory in the state-space at any point in time and over time. The state of the system at any instant in time is represented by a point in state-space and the trajectory through state-space represents the change in the system as a function of time. 'Trajectory' refers to the system's evolving state or behaviour over time. Its evolution is represented as a path through the state-space.

When the equation contains non-linear functions, that is, functions in which the value of the output is not directly proportional to the sum of the inputs, then a qualitative rather than a quantitative approach to differential equations is required. Rather than seeking to predict exact future states, this qualitative method seeks to predict tendencies toward long term behaviour.[67] In a non-linear or complex, dynamical system, there may more likely be areas of phase space into which the system moves because they are stable. These are known as attractors. The degree of stability of an attractor is represented by the depth of its basin; the greater its stability, the steeper the walls of the basin.

The dynamic approach to cognition in brief, is that cognition in living entities is a process which may be understood using the resources of DST. In biological cognitive systems, feedback mechanisms are required for moment to moment adaptation to the environment. Mechanisms which amplify processes are referred to as positive and mechanisms which constrain processes are referred to as negative. Both types of feedback are required for the organism to remain viable. Feedback mechanisms result in complex, adaptive, dynamic systems wherein outputs are not equal to the sum of inputs.

The organism reconciles its operational closure with thermodynamic openness through feedback at multiple scales. This is a critical aspect of dynamic systems. Moment by moment the organism 'monitors' its internal status and through feedback loops, adapts as necessary to maintain homeostasis (or arguably, allostasis) of critical systems. In this sense, the organism and the environment become structurally coupled as a larger machine. As Varela said:

[67] Thompson (2007). 38-43.

> "If one says that there is a machine M in which there is a feedback loop through the environment, so that the effects of its output effects its input, one is in fact talking about a larger machine M' which includes the environment and the feedback loop in its defining organization."[68]

Environmental perturbations and internal dynamics may require the organism to adapt in order to maintain functional integrity. The adaptations may then modify organismic function which may then affect behaviour. What is it that monitors the organismic status moment to moment? In earlier times a homunculus was hypothesized. In organisms with a complex nervous system, the brain, in part, serves the control or modulatory function. Looped feedback at multiple scales is coordinated by the nervous system which adapts body to environment and environment to body recursively in real time. Non-linear functions mathematically describe such behaviour and qualitative solutions as to the state of the system at any time are required. The role of the nervous system in this regard will be discussed in Chapter 3.

In part, the controversy over the use of the terms allostasis and homeostasis hinges on the issue of recursive feedback. The allostasis position recognizes the role of the nervous system as a central feature in virtually all feedback processes whereas the homeostasis concept focuses more locally on the role of the specific organismic system involved in feedback.

A central thesis of the both enactivism and the eco-dynamic paradigm is the interdependence or entanglement of living organisms and multiple features of the environment due to looped feedback. Maturana and Varela's view of autopoiesis is paradigmatic; recurrent environmental factors may create perturbations to which an organism adapts; and the environment adapts in relation to the impact of the organism.

The hypothalamic-pituitary-adrenal (HPA) axis is an example of multi-systemic, positive and negative feedback loop. Activation of the hypothalamus arises in an emergency and triggers an acute stress response. The hypothalamus releases corticotropin releasing hormone (CRH) which causes the pituitary glands to release adrenocorticotropic hormone (ACTH) which in turn acts on the adrenal glands to cause the release cortisol. Cortisol prepares the body to deal with the emergency. This is the positive feedback aspect of the mechanism. Once the emergency is over, the blood cortisol level decreases which in turn

[68] Varela, F. (1979). *Principles of biological autonomy.* New York: Elsevier 12.

deactivates the release of hormones from the hypothalamus and the pituitary glands. This is the negative aspect of the feedback loop. Systemic homeostasis then returns. The HPA axis and the application of dynamic systems analysis, will be discussed in greater detail in chapter 3 in relation to the mediation of the nervous system in response to environmental circumstances.

Specifically focusing on the establishment and maintenance of the human mind, I will argue that the structure and function of mind are the result of the interplay of complex dynamic systems at multiple scales. In fact, the human mind is an interdependent component of the larger system composed of brain, body and world.[69] The following chapters of the dissertation elaborate this argument.

2.2.1. Coordination Dynamics

A consequence of complex adaptive dynamics is that heterogeneous and homogeneous elements must coordinate function in order to operate successfully. In the human brain, dyads usually thought to be polar opposites are in fact complementary; for example, on the one hand, local and segregated function (e.g. individual neurons) and on the other hand, global and integrated function (e.g. neural networks). According to Kelso and Engstrom, both co-exist and the realization of one at any point in time exists in dynamic instability.[70] They develop the complementarity theme, vital to coordination dynamics, The *Complementary Nature.* Coordination dynamics is the term they use to describe the set of theses that explain how living organisms coordinate functions at multiple scales. This is a view for which I have great sympathy.

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[69] "The nervous system, the body and the environment are highly structured dynamical systems, coupled to each other on multiple levels. Because they are so thoroughly enmeshed biologically, ecologically and socially- a better conception of brain, body and environment would be mutually embedded systems rather than as internally and externally located with respect to one another. Neural, somatic and environmental elements are likely to interact to produce (via emergence as upward causation) global organism-environment processes, which in turn affect (via downward causation) their constituent elements." Thompson, E. and Varela, F. J. (2001). Radical embodiment: Neural dynamics and consciousness. *Trends in Cognitive Science* 5(10). 423-424. Thompson acknowledges that these points are speculative.

[70] Kelso, J.A.S. and Engstrom, D.A. (2006).

Coordination dynamics subscribes to the following ideas:

> "Complementary pairs are multimodal and dynamical."

Each complementary aspect, considered in isolation, represents a polar mode and exists only as an ideal. In fact, complementary pairs co-exist in metastability. The term "metastability" refers to the tendency to manifest either as a disposition or a state depending upon contextual conditions. The nature of complementary pairs can be conceptually grounded in multifunctional metastable coordination dynamics.

> "Complementary aspects can behave both as 'tendencies' or 'dispositions' and as well-defined states."

The aspects may be stable and therefore present as states or they may exist in dynamic instability, that is, as tendencies. These two situations are complementary. Because of this attribute they may be open to multiple interpretations. They can appear to exist as separate and bounded. Even so, each affects the behaviour of the other. Or they may appear unbounded and 'multifunctionally dynamic'. That is, as coupled dynamic tendencies complementary pairs may merge one moment and separate the next.

Phenylketonuria (PKU) is a good example of a disorder that demonstrates how a genetic defect (two mutated recessive alleles of the PAH gene) may act either as a disposition or state. One result or the other will exist at any point in time; both are metastable and complementary.

Normally a single gene (referred to as the PAH gene) would code for the liver enzyme phenylalanine hydroxylase (PAH)[71]. Two recessive alleles of the gene would create the enzyme. But in PKU, the enzyme is not created due to the presence of the two mutated alleles. Therefore phenylalanine, a required amino acid found in dietary protein, cannot be metabolized into tyrosine. The failure to metabolize ingested phenylalanine results in an excessive accumulation of this amino acid. Phenylalanine is neuro-toxic in excess quantities

[71] Most genetic disorders are caused by the contribution of hundreds or even thousands of genes acting in concert, each making a minor contribution. However, there some disorders such as PKU and Huntington's disease that are caused by a single gene.

and when such quantities cross the blood-brain barrier the result is severe mental retardation, seizures, and other problems.[72]

In brief, the treatment of PKU requires affected individuals to modify their diets to severely restrict the intake of protein and to take a tyrosine supplement. While the cause of PKU is genetic, the manifestation of symptoms is contextual, that is, due to the presence of excessive phenylalanine in the diet. So, one can accurately say both that the disease is due to a genetic condition or that its manifestation is due to dietary factors. A carefully maintained diet may eliminate what would otherwise be severe neurological consequences. The genetic factor and the dietary factor co-exist in metastability (in the language of coordination dynamics) and in dynamic instability (in DST terms). Strict adherence to the proper dietary regime facilitates normal cognitive function as long as it is maintained but lax adherence will result in somatic and cognitive dysfunction. In the case of strict adherence, dietary regime exhibits a deep basin of attraction. However, the genetic factor always exists as a tendency (to cause symptoms of PKU) and one may suffer irreversible cognitive and somatic damage if the dietary regime is not maintained. In that case, the genetic factor exhibits a very deep basin of attraction as it assures that damage and dysfunction will occur. PKU is an example of a dynamic disease in the sense that its manifestation at any time and over time depends upon behaviour. A dynamic combination of genomic and contextual factors governs its management.

2.2.2. Self-Organizing Coordination

Basic patterns of coordination can arise and change spontaneously in a Self-organized fashion in response to certain conditions. Many individual elements interact with each other and their environment to Self-organize into dynamic patterns. Complex patterns and functions may arise out of local interactions. Consider the example of the Haken-Kelso-Bunz

[72] Russell, P. (1998). *Genetics* (5th ed.). Menlo Park, CA: Benjamin/Cummings. 123-125; 272-273.
Plomin, R., DeFries, J., Knopik, V., and Neiderhiser, J. (2013). *Behavioural Genetics* (6th ed*).* New York.: Worth Publishers. 11-12;165-166;
Phenylketonuria http://wikipedia.org/wiki/phenleketonuria. Accessed 11 May 2014.

(HKB) model of phase transitions in human finger movements.[73] The model was created to mathematically describe the following experiment originally conceived by Kelso:

Hands were placed palms down, only the index finger of each hand was extended. The instruction given was that the index fingers should move side to side with the same frequency for each finger and in cadence with a beating metronome (one cycle of movement for each beat). There are two possibilities as to how one might begin. Initially the participants were instructed to move their fingers in the same direction at the same time (referred to as anti-phase) or to move in opposite directions at the same time so they are alternately pointing toward and away from each other (referred to as in-phase). The participants were further instructed to stay with the pattern of finger movement that is comfortable (and that arises spontaneously) and to not attempt to impose any particular pattern. The cadence of the metronome was gradually increased then decreased.

When participants began with fingers moving antiphase, as the metronome was speeded up, at a critical point referred to as a bifurcation, a phase transition occurred; finger movement switched from anti-phase to in-phase. When the metronome was later slowed down in-phase movement continued. When finger movements began moving in-phase they remained in-phase as the metronome was speeded up and did not switch phase, and again they remained in-phase as the metronome was slowed down. Why the switch from anti-phase to in-phase? And why did in-phase movement never switch to anti-phase?

The HKB model provides a mathematical equation for this phenomenon that illustrates why the phase transition occurred in one case and not the other and importantly, was able to accurately make some predictions. Frequency of oscillation (synchronized two-finger movement) is the control parameter. It represents the cycle to cycle period of the finger movements. A phase transition occurred as the frequency increased. Phase transition varies in dependence on the control parameter. The order parameter is relative phase (the phase relation of one finger to the other). Phase transition from anti-phase to in-phase occurs as a result of dynamic instability. The phase portrait which plots frequency of oscillation against phase transition reveals that the most stable attractor is in-phase. Anti-phase is also an attractor although less stable. Kelso writes:

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[73] Kelso, J.A.S. (1995). *Dynamic patterns: The Self-organization of brain and behaviour.* Cambridge, Mass: MIT Press. 44-60; Walmsley, Joel (2005). *Mind out of time: Emergence and explanation in dynamical cognitive science* (PhD Dissertation). 40-45.

> “...while people can produce two stable patterns of low frequencies, only one pattern remains stable as frequency is scaled beyond a critical point.”[74]

Joel Walmsley summarizes:

> “in the language of dynamical systems theory, there are two stable attractors at low frequencies and a bifurcation at a critical point, leading to one stable attractor at high frequencies.”[75]

The coordinated movement of the fingers results from the cooperation of a multiplicity of elements--muscles, ligaments, tendons, and nerves and the phase transition is result of this Self-organized complex, adaptive system. This is an example of the self-organised pattern of coordination that can arise spontaneously in complex systems.

2.3. Sensemaking, Embodiment and Functional Information

Thompson says:

> “According to the enactive view, living beings are sense-making beings; they enact or bring forth significance in their intimate engagements with their environments. Here is how Varela put this idea at the outset of [an] early paper: ‘Order is order, relative to somebody or some being who takes such a stance towards it. In the world of the living, order is indeed inseparable from the ways in which living beings make sense, so that they can be said to have a world.”[76]

This is as true for human beings as it is for bacteria. All living beings make sense of the world through their physical organism as their means of engaging with the world. Positive and negative valence is determined by the particular structure of the organism. For human beings, their contact with the world is through the senses. And it’s through the senses then that one orients intentionally toward the world. But additionally, it’s through the mind and body that experience is given meaning. Experience does not merely imprint as a hot seal impresses wax. Rather, experience is interpreted within the context of other experience to

[74] Kelso, J.A.S (1995). 49.
[75] Walmsley, J. (2005). 42.
[76] Thompson, E. (2011). Living ways of sensemaking. *Philosophy Today.* 114.

give particular, perhaps unique salience. The unique, ongoing concatenation of mental and physical engagement with the world creates a nexus of experience and neural connections unique to each individual and constitutes what may be considered sense-making or salience at a higher level. The orientation one adopts in response to higher level valence may be determined by one's complex dynamical cognitive structure, one's somatic structure and engagement with the world. Two motives may be discerned. On the one hand, as with all living organisms, one seeks that which enhances or extends life or is perceived to do such. On the other hand, another motive orients toward that which brings pleasure and/or avoids pain or is perceived to accomplish such, whether accurate or not. These two primal motives may either complement each other or conflict.

Thompson again:

> "… [L]iving as sense-making in precarious conditions is the living source of intentionality. Sense-making is threefold: (1) sensibility as openness to the environment (intentionality as openness); (2) significance as positive or negative valence of environmental conditions relative to the norms of the living being (intentionality as passive synthesis— passivity, receptivity, and affect); and (3) the direction or orientation the living being adopts in response to significance and valence (intentionality as protentional and teleological)."[77]

The eco-dynamic paradigm considers both sense-making and higher-level salience as philosophically and pragmatically germane. For example, if one desires to change one's orientation toward life (e.g. to break a habit or change a personal disposition) one may be able, by intentionally directed action or "downward mental causation", to accomplish it. As such, the eco-dynamic paradigm which I am developing in this dissertation integrates valence and salience, connecting threads amongst the disciplines of psychology, philosophy, neuro-biology and psychotherapy. Some of these threads will be elaborated in the following chapters.

Kelso's notion of information flow in organisms is closely related to Varela's concept of sensemaking. According to Kelso and Engstrom,[78] functional information refers to specific and meaningful observable effects on coordination patterns. Information is functional if it helps an organism survive or function in the world. Functional information is time and

[77] Ibid. 119-120.
[78] Kelso, J.A.S. and Engstrom, D. (2006). 97-101.

context specific; what is functional for an organism at one time may not be functional at an earlier or later time. And what is functional in a given context may not be functional in another context. Functional information may arise in the coupling of endogenous (e.g. genetic) and exogenous (e.g. diet) factors. I mention information briefly only because of its relation to sensemaking. I will not discuss information theory in detail as it lies outside the concerns of the present investigation.

2.4. Emergence

The concept of emergence is understood differently in the various disciplines and there is no settled agreement on the use of the term. To complicate matters further, there are several varieties of emergence. An emergent process arises from collective Self-organization of a network.

It "arises spontaneously from locally defined and globally constrained or controlled interactions of those elements and does not belong to any single element. The enactive approach… builds on this notion of emergence but reformulates it as 'dynamic co-emergence' in which part and whole co-emerge and mutually specify each other."[79]

The network may be construed to include the environment and accordingly, I shall argue in the following chapters that environmental context plays a part in collective Self-organization. In chapters three and four, I am concerned initially with emergence as biological and psychological phenomena.

A simple example of emergence in complex dynamic systems is Benárd cells. Recall that when a pan of water is heated from below and cooled from above, a temperature gradient is created between the top and bottom layers of water. When the lower level components (molecules) have sufficient kinetic energy (e.g. the bifurcation point), a phase transition occurs, and the water self-organises into hexagonal convection cells. This illustrates upward (local to global) causation. Lower level components are then constrained in their degree of freedom. This illustrates downward (global to local) causation.[80] As previously stated, the

[79] Ibid. 60.
[80] Ibid.

temperature gradient is the control parameter. It does not impose the emerging flow patterns. The amplitude of the convection rolls is the order parameter of the system and constrains the behaviour of the fluid molecules in that it reduces their freedom of movement (See section 2.2 for a discussion of Reyleigh-Benárd instability).
…..Downward causation in complex dynamic systems manifests as changes to control parameters (e.g. temperature gradient) and boundary conditions.[81] The combination of upward and downward determination is referred to as circular causality and is characteristic of systems that display emergence.

Thompson provides the following definition of emergence in complex, autonomous systems:

> "A network, N, of interrelated components exhibits an emergent process, E, with emergent properties, P. if and only if:
> (l) E is a global process that instantiates P and arises from the coupling of N's components and the nonlinear dynamics, D, of their local interactions.
> (2) E and P have a global-to-local ("downward") determinative influence on the dynamics D of the components of N.
> And possibly:
> (3) E and P are not exhaustively determined by the intrinsic properties of the components of N, that is, they exhibit. "relational holism."[82]

This definition expresses strong or ontological emergence in which "the whole is more than the sum of its parts and their intrinsic properties."[83] Perhaps the most striking example of an emergent property is life itself. Consider a simple single-celled organism. In such an organism there are thousands of biochemical processes and structures, none of which in themselves constitute life. It is only due to the Self-organization of all these processes and taken together that life emerges. And if one considers the origin of life, it is generally agreed that life arose from chemical elements none of which individually are alive. It is believed that all life arose from such simple organisms. Evolution favoured and therefore fostered complexity of process and structure. If one were to apply Thompson's criteria to life as an emergent feature it might look something like this. 1) Life is an emergent and global process that instantiates the properties of life (metabolism,

[81] Ibid. 60-62.
[82] Thompson (2007). 418.
[83] Ibid. 417.

reproduction, elimination, etc.) and arises from the coupling of the network of the organism's components and the nonlinear dynamics of their local interactions. 2) Life as a global process (and its properties) has a global-to-local determinative influence on the dynamics of the components of the network. The maintenance of life and life functions constrain the organism's components and conversely; 3) Life and its properties are not exhaustively determined by the intrinsic properties of the components of the network.

It seems reasonable to hypothesize, and I will argue in chapters 3 and 4, that awareness too is a global, emergent process arising, in part, from the coupling of the networks of the brain. Although not universally agreed, I will argue that awareness has global to local determinative influence on the components of the collective networks and the properties of awareness are not exhaustively determined by the intrinsic properties of the components of the network. Both emergence and circular causality play crucial roles in brain function. Cognition requires the transient integration of numerous widely distributed interacting brain regions. Large scale dynamic patterns emerge from local and distributed neuronal firing.

"Large scale integration corresponds to the formation of transient dynamic links between widespread neural populations."[84]

These in turn constrain the activities of local neuronal populations. Numerous examples strongly suggest the likelihood of global to local neural influence. There is of course a technical issue, as yet unresolved, as to whether downward constraint equals downward causation. That issue aside, an example is the ability to affect somatic and neural function by meditation practices. This will be discussed in detail in the next chapter.

In the language of dynamic systems, we may think of emergence as a phase transition that arises from 'lower level' causes and conditions. A phase transition occurs when qualitative changes to a system occur which typically allow behaviour such as cognition that might not otherwise have been possible. One may consider awareness as a global process arising from multiple 'lower level' networks the control parameters of which are not yet understood. Bifurcations are connected with phase transitions. In regard to awareness, we

[84] Ibid. 62.

may consider a bifurcation to occur when it first arises as, for example, when one transitions from unconsciousness to consciousness as anaesthesia wears off.

2.5. Concluding Remarks

I have argued that Self-organization as skilful know-how (cognition) in mastering a wide range of environmental conditions and adapting to a wide variety of changing circumstances is unique to living beings. These abilities can be found in both the most simple and complex organisms. Common to all, life-sustaining activities take place in real time due to the interaction and coordination of numerous internal and external elements. DST is able to provide a framework for time-sensitive adaptation and for the coordinated contributions of numerous elements. Coordination dynamics provides the tools to identify dynamic patterns at multiple scales.

In the next chapter, I discuss the interdependence of epigenetics and neurophysiology, especially neuroplasticity, in the establishment and maintenance of mind. Again, DST plays an important role in analysing and explaining the complex relationships between brain, body and environment. Circular causation (upward and downward causation) and emergence are clearly in evidence and underlie the interdependence of these specific aspects of nature and nurture.

Chapter 3

Interdependence of Nurture and Nature: Epigenetics and Neuroplasticity

3.0. Introduction

In chapter 2, I argued that the enactivist schema of brain-body-world is foundational in grounding the dynamic interaction of multiple elements at different scales of function. Further, I argued that Dynamic Systems Theory (DST), a non-reductive methodology, is well equipped to analyse and explain these dynamic interactions. In this and succeeding chapters, I will demonstrate this to be the case at successively expanding scales of function. In this chapter, I argue that recent scientific research in epigenetics and neuroplasticity demonstrates that the brain-body-world schema is the proper conceptual framework to understand the dynamic, functional processes of epigenetic and neural interdependence. And the tools of DST are well suited to analyse and explain how epigenetic and neural functions are impacted by context and experience. I make the case that the epigenome, brain and environmental context operate as dynamic systems structurally coupled to bring about the emergence of cognitive functions. In the following chapter, I make a similar case with respect to interpersonal and social relationships and relationships with technology.

In this chapter, I also show that different conceptions of neural function, often considered to be opposed (such as local to global function versus global to local function) are sometimes metastable features (in the sense discussed in section 2.2.1) existing either as tendencies or states; either may operate at a moment in time depending upon context. I argue that, with respect to mind, elements normally considered as aspects of nature and nurture may also be metastable (depending upon scales of time and context); in fact, elements referred to as aspects of nature are shaped by elements of nurture and *vice versa*. I show that some elements considered to be natural such as the structure and function of the genome and brain cannot be separated from elements of nurture such as context and experience, in the establishment and maintenance of mind.

In contrast, molecular neuroscience, which utilizes a reductive methodology, treats the brain as a subject of study whose functions may be understood in terms of its functional mechanisms alone. And when functional mechanisms are investigated utilizing this methodology, time and timing is not considered; the dynamics of the mechanism adds a complicating layer. Reductive molecular neuroscience therefore divorces functional mechanisms from contextual and experiential triggers which it considers peripheral. When considered functionally and dynamically however, context and experience are constitutive of mental function, I argue in this chapter. It is worth noting again that reductive and nonreductive methodologies are complementary; their concerns relate to states versus processes, respectively.

3.1. Nature versus Nurture

The nature-nurture debate has recently played out in the characterisation of consciousness as reductionist versus nonreductionist. According to the former view, consciousness arises solely from the physical structures and functions of the brain and can be explained in terms of these lower level features. As Francis Crick has said:

"You, your joys and sorrows, your memories and ambitions, your sense of personal identity and free will are, in fact, no more than the behaviour of a vast assembly of nerve cells."[85]

To explain consciousness for example, one must explain *inter alia* the functioning of neurons. And to explain the functioning of neurons, inter alia, one must understand the operation of genes.

The reductionist position may be contrasted with that of the nonreductionist according to which, in one version, consciousness supervenes on the physical, but cannot be reduced to it. Enactivism takes this position. To put the position simplistically, the brain mediates consciousness, but the brain, body and contextual experience jointly are constitutive of consciousness. So, consciousness cannot be reduced to brain function alone.

[85] Crick, F.H.C. (1994). *The astonishing hypothesis: The scientific search for the soul.* London: Simon and Schuster. 3.

Consciousness is an ongoing process embedded in time, in the body and in the world and as such, must be understood dynamically and holistically.

While I am concerned in particular with the nature-nurture dichotomy as it applies to the establishment and maintenance of mind, it is also necessary to see the debate in the larger context of polarities (such as rationalism versus empiricism) in need of reconciliation. Such a move can happen within the framework of enactivism and coordination dynamics, since the latter conceives many polarities as complimentary features, co-existing in a state of metastability, the manifestation of which depends on context.

In its original form, the nature-nurture debate centred on the epistemological question of how one comes to gain knowledge. However, the nature-nurture controversy also has ramifications for the philosophy of mind. For example, when considering the constitution of mind, one might ask whether its function is predominantly a product of nature (e.g. brain structure and function) or nurture (influences of environmental context including experience) or a combination of both.

In relation to the epistemological approach to the nature-nurture controversy, Plato, believed that the human mind innately contained knowledge of 'Forms', the universals or abstract essences (e.g. the good), of which particulars of the same type (e.g. good acts) were examples. Because typically, one was not aware that they possessed knowledge of Forms, Plato believed that the knowledge it had to be evoked through a process of dialectic.[86]

Aristotle, on the other hand, argued that universals did not exist as Plato conceived. Knowledge was to be gained empirically, through the senses. Once knowledge was gained in this manner, concepts could be abstracted by the process of inductive reasoning.[87]

This difference between the Platonic and Aristotelian views set the stage for the dialectical controversy of rationalism versus empiricism. Roughly, the epistemological debate between rationalism and empiricism was whether knowledge was to be gained by empirical means alone or by innate ideas or faculties. Rationalism in the 17th and 18th centuries had elements of nativism, the belief that innate ideas and faculties existed in the human mind. For example, Descartes, a rationalist, held that space was innate to the

[86] Plato, Phaedo (trans. Hugh Tredennick). 40-98; Plato, The Republic , books 7 and 8 (trans. Paul Shorey). 575-844; in Hamilton, E. and Cairns, H. (Eds.). (1961/1989). *Collected works of Plato.* Princeton, NJ: Princeton U.P.
[87] Aristotle (McKeon, R. Ed.). (1941). *The basic works of Aristotle .* New York: Random House.

human mind. Kant, who described his view as transcendental idealism, believed that space was a sensible form of human intuition and not an entity in its own right. Kant critiqued aspects of both rationalism and empiricism. Locke was an empiricist for whom knowledge was gained by the senses. Mind was a 'blank slate' (tabula rasa) upon which experience wrote.[88] Likewise, Hume was an empiricist who believed that perception was the basis of mental content. In reconciling these apparently opposing views, an aphorism of Bacon is apt:

"Those who have been engaged in [natural philosophy] divide into [empiricists] and [rationalists]. The [empiricists], like ants, merely collect and use particular facts; the rationalists, like spiders, make webs out of themselves. But the bee takes a middle course: it gathers its material from the flowers of the garden and the field, but uses its own powers to transform and absorb this material. A true worker at [natural] philosophy is like that: he doesn't rely solely or chiefly on the powers of the mind like a [rationalist], and he doesn't take the material that he gathers from natural history and physical experiments and store it up in his memory just as he finds it like an [empiricist]. Instead, he stores the material in his intellect, altered and brought under control."[89]

Bacon's point is that alone, neither the empirical nor rational approach to (natural) philosophy brings about understanding of the world. Rather, the use of empirical data worked over by the mind, that is, the combination of empirical and rational efforts, brings knowledge.

Let us take a moment to reflect on the rationalist-empiricist debate. These positions abstract from the way mind functions at a lower level. Although Hume tried to avoid this abstraction, he did not have the tools to succeed. Roughly, rationalists abstractly focus on the manner in which knowledge is gained *from the inside* whereas empiricists abstractly focus on the way knowledge is gained *from the outside*. In my view, both positions conceptualise at too high a level. Lest we forget, both views are concerned with the manner in which the mind of an autopoietic being functions. This is best considered biologically as philosophy of mind best theorises when it is biologically informed. The enactivist approach suits well in this regard. It is a biologically informed approach to the philosophy of mind.

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[88]Jones, W.T. (1969). *A history of western philosophy: Hobbes to Hume 3.* 239-259.
[89]Bacon, F. *Novum organum.* Aphorism 1.95. Accessed 20 January 2019 https://www.earlymoderntexts.com/assets/pdfs/bacon1620.

Varela theorised that mind and world co-specified each other.[90] This conclusion was based on biological data gathered empirically. In this and succeeding chapters, I demonstrate the manner in which this bidirectional co-specification occurs at successively higher scales of function.

In its present form, the nature-nurture debate with regard to mind may be framed as whether nature (neurobiology, genetics) or nurture (experience, environment, context) are responsible for its establishment and maintenance. Virtually no one takes the extreme position that mind is created solely by the genome or by experience. Most scientists and social scientists now believe that mind is the product both of nature and nurture but they may nevertheless disagree on a variety of particulars. In what follows, I argue that epigenetic and neurobiological functions and processes are critically interdependent with experience and context; and conversely, contextual experience is critically interdependent with epigenetic and neurobiological function. This is the first level of bi-directional co-specification with which I am concerned. With respect to mind then, *pure* nature or nurture exists only as an ideal construct. And yet, paradoxically, I will show that the distinction between nature and nurture still has viability, if only methodologically.

According to Maturana and Varela, self-organization was the lynchpin concept upon which apparently (but not actually) opposing concepts along the lines of nature-nurture were employed. Although they did not speak in terms of nature-nurture, the concepts of operational closure and thermodynamic openness highlighted positions which they successfully reconciled. Operational closure or autonomy roughly echoes the nature component in that the focus is on the Self-organisation of the organism. Thermodynamic openness roughly can be seen as the nurture component as its focus is on the interchange of energy and matter with the environment. While Maturana and Varela acknowledged, of course, that environment impacted the organism's function, indeed was required by it, they also affirmed the organism's organisational autonomy in the exchange. The impact of environment upon an organism was only such as the Self-organization of the organism would allow. Organism and environment co-specified each other. The reconciliation of these two positions arises from the complementarity of autonomy with thermodynamic

[90] Varela, Thompson, and Rosch (1993).

openness. They referred to this position as *structural coupling.* This theoretical position was biologically demonstrated.

In the Maturana and Varela theoretical construct, Self-organization was conceptually independent of specific structure. Rather, Self-organization was functionally rather than structurally specified in that Self-organisation theoretically could occur through various structural implementations. Yet concretely, it is obvious that any autopoietic organism requires a specific physical structure. And specifically, any organism with a nervous system must also have a genome as an integral component of the neural mechanism. In the previous chapter, we saw that the dominant 'received view' amongst molecular biologists and geneticists is genocentric and according to this view, the genome is the fundamental basis of life. It alone contains the information that directs structure and function. The so called *central dogma*, first formulated by Francis Crick, asserts that information flows in only one direction from the DNA to RNA to create protein.[91] In this chapter I argue, contrary to the received view, that the genome, the neural mechanism, and the environment act in a coordinated, bi-directional and interdependent manner to such an extent that it becomes misleading at best, incorrect at worst, to describe organismic function generally and mental function specifically, functioning in time, independent of the environment in which it is embedded. Furthermore, I shall show that these three components---genome, brain and environment--- can be characterised as a dynamic system.

The psychologist Donald Hebb famously analogized the relationship between nature and nurture. It has been reported that after a lecture, when he was asked by a journalist which factor was more important in the development of personality, genes, or the environment, he responded that the question was analogous to asking which is more important, length or width, in the construction of a rectangle[92]. At the time, Hebb's response was not mainstream thinking[93] at least among social scientists, especially psychologists, who believed that environmental influences prevailed over genetic function. But now it is commonly believed by many informed neuroscientists, psychologists and others that both

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[91] Crick, F.H.C. (1994).

[92] Francis, D. and Kaufer, D. (2011). Beyond nature and Nurture. *The Science Magazine* https://www.the-scientist.com/reading-frames/beyond-nature-vs-nurture-41858. Accessed 3 May 2014; See also Hebb, D.O. (1980). *Essay on mind.* Hillside, N.J.: Lawrence Erlbaum Associates. 70-78

[93] Through much of the twentieth century, a common, though not unanimous belief amongst psychologists was that there was no innate human nature and that the mind was predominantly a blank slate. Pinker, S. (Fall 2004). Why nature and nurture won't go away. *Daedalus.*

nature and nurture interdependently contribute to the formation of personality, behaviour and more generally, to the shaping of the human mind.

Notwithstanding this consensus, the nature-nurture distinction continues to have vitality. Pinker (2004) has detailed some reasons.[94] He believes that even though genetics and environment are interdependent in the creation of a specific trait or behaviour, it may still be necessary to evaluate the role of each separately in order to understand the mechanisms at play in the interrelationship. Furthermore, nature and nurture are not always interdependent in the determination of human behaviour. Pinker cites the example of language. Although people may be constituted to learn language generally, the specific language they learn is entirely a matter of environment. Yet again, the attribution of nature in a specific instance may be both politically incendiary and incorrect.[95] Consider the example of the eugenics movement of the 19th and 20th centuries which promoted the cleansing of the gene pool through sterilization and harsher measures. The Nazi programme of genocide was the most drastic result of this misunderstanding. The point is that interpreting the interdependence of nature and nurture in the manifestation of a specific trait, characteristic or behaviour is complex. Each human trait must be evaluated at multiple scales across the brain-body-world schema.

The geneticist Michael Meaney, arguing from the biologist's perspective, would appear to disagree with Pinker. Meaney's view is that the nature-nurture distinction is arcane. He says:

"...Life does not emerge as a function of either [nurture or nature alone]. It is equally wrong-headed to assume that, oh yes, phenotype derives from both nature and nurture. This would be only to repeat the misunderstanding in kinder, gentler terms, as if biological and social scientists had shaken hands and then gone off into their own corners of the universe to study "lengths" or "widths" [rather than rectangularity]. Indeed, both conclusions are derived from additive models of determinism where gene + environment=phenotype. Such models make no biological sense whatsoever. It is not nature *or* nurture. Nor is the development of phenotypes [created by] nature *and* nurture. To paraphrase Richard Lewontin, life emerges only from the *interaction* between the two. There are no genetic factors that can be studied independently of the environment, and there are no environmental factors that function independently of the genome. Phenotype

[94] Ibid. 1-13.

[95] The Historical Context in *Genetics and human behaviour: The ethical context.* http://nuffieldbioethics.org/wp-content/uploads/2014/07/Genetics-and-behaviour-Chapter-2-Historical-context.pdf.

emerges only from the interaction of gene and environment. The search for main effects is a fool's errand."[96]

Meaney raises a few important points. When one considers phenotypes biologically and developmentally, as a process developing in time, genetic and environmental factors interact dynamically to create an amalgam product. The complexity and dynamism of the relationship between genetic and environmental factors renders an additive model (nature plus nurture) inaccurate. It is within this context that his statement that "there are no genetic factors that can be studied independently of the environment" must be understood.

The term *product* must be understood as process at an instant of time, for developmental product is itself always a time slice of a continuous process.[97] In a phase portrait, the product of genetic and environmental interaction at a particular time is represented by a point within phase space. The change in the product of these two features over time is represented by a trajectory in phase space. And of course, depth of the basins of attraction of both genetic and environmental factors may vary from moment to moment. The variations in the depths of the basins indicate that the interaction between these two factors is dynamically unstable but nonetheless affects the path of the trajectory.

Meaney's point about main effects bears amplification as well. What he is referring to is the attempt to attribute cause and effect to either genes or environment independent of the other in a dynamic process. In a dynamic system where both environment and genetics interact interdependently over time, attributing cause and effect can be simplistic and misleading.

Finally, Meaney's attribution of emergence to the phenotypical product of nature and nurture is important. He uses the term, I believe, in the technical sense to refer to a complex property or characteristic which cannot be predicted in advance because it is the product of complex, dynamic interaction. This is typical of such dynamic systems.

It is my view that Meaney's and Pinker's views are not contradictory but rather, address the nature-nurture question from different perspectives. The apparent incompatibility is rectified when we more closely analyse their positions in relation to the context within

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[96] Meaney, M. (2006). Nature, nurture, and the disunity of knowledge. *Annals of the New York Academy of Sciences* . https://nyaspubs.onlinelibrary.wiley.com/doi/full/10.1111/j.1749-6632.2001.tb03470.x.
[97] See Oyama, S. (2000). *The ontogeny of information: developmental systems and evolution* (revised 2nd Ed.). Raleigh, N.C: Duke University Press.

which they speak. Meaney believes that the nature-nurture question is a question of how phenotype causally arises from genotype.[98]

He makes the point that biologically complex traits can only arise by an emergent interdependence and not by an additive or alternative relation between nature and nurture[99]. This is not a surprising view for a geneticist. On the other hand, Pinker is not addressing the issue from a biological perspective. Rather he attempts to rationalize the practical and conceptual value of distinguishing nature and nurture. So rather than focusing on causation, Pinker focuses on how to conceive this interdependence.

There are other confusions as well that continue to plague the nature-nurture debate. The failure to take account of time and timing as a significant factor in the debate leads to a failure to distinguish between process and state. Seen as an evolutionary process spanning long time periods, the interdependence of the dynamics of the genome, epigenome and environment is inescapable. The epigenome refers to chemical compounds that attach to DNA due to contextual signals from the environment and direct DNA to either express or repress the manufacture of proteins, hormones, neurotransmitters etc as required for adaptation moment to moment to the environment. However, in the study of the process by which epigenetic mechanisms are expressed or repressed it may be methodologically useful, at least initially, to examine discrete functions as if they were independent and as if they were instantaneous states rather than processes. This methodology artificially but nevertheless usefully simplifies research. However, dynamic systems theory may be employed to more realistically portray the process of the interaction of the genome,

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[98] "The nature–nurture debate is essentially a question of the determinants of individual differences in the expression of specific traits among members of the same species."

"Variations in phenotype reflect the influence of environmental conditions during development on cellular functions, including that of the genome. The recent integration of epigenetics into developmental psychobiology illustrates the processes by which environmental conditions in early life structurally alter DNA, providing a physical basis for the influence of the perinatal environmental signals on phenotype over the life of the individual".

"The fundamental question is that of the relation between genotype and phenotype: How do variations in the genotype influence selected traits at any point over the lifespan?"

Meaney, M. (2010). Epigenetics and the biological definition of gene x environment interactions. *Child Development* 81(1*).* 41–79; 41-42.

[99]"... the argument presented here is that the notion of a main effect of either ''gene'' or ''environment'' on the development of individual differences in complex traits is biologically fallacious. Instead, the development of the individual is best considered as the emergent property of a constant interplay between the genome and its environment". 45.

epigenome and environment in real time. The failure to recognize that both state and process analyses have different but useful roles creates the appearance of a conflict where none exists.

In this dissertation, I consider the nature-nurture perspective both philosophically and biologically as a dynamic process. As Meaney has pointed out, biology does not and cannot separate the genetic and environmental components since they interact interdependently at all levels of biological complexity. However, when seeking to understand the contribution of epigenetics and environment to the development and stability of complex behaviours or mental traits, it may make sense to evaluate the two separately, recognizing that this separation is artificial but methodologically useful. This technique is employed by quantitative behavioural genetics which is not a methodology with which this dissertation is primarily concerned. In fact, behavioural genetics is not dynamically focused. The purpose of the brief discussion of behavioural genetics is primarily to discuss the twin model which will lead to a discussion of epigenetics according to which gene-environment interaction creates phenotypes.

3.2. Human Behavioural (quantitative) Genetics

An in-depth discussion of this topic is beyond the scope of this dissertation. However, there is an aspect of behavioural genetics that is relevant to this dissertation. That is the twin method (see 3.3.1). Briefly, this method compares identical twins (monozygotic) and fraternal twins (dizygotic). When both groups live with family, environment is considered to be held constant and any statistical variation is considered to be due to genetic influence. In order to discuss the twin method, brief background in behavioural genetics is required.

Behavioural quantitative genetics, a subspecialty of psychology, studies complex phenotypical characteristics, for example, intelligence or schizophrenia, and seeks to allocate the contribution made by genes and environment in each population studied. An important aspect of this field is referred to as gene-environment interaction, usually abbreviated as GxE interaction, which designates the relative contribution of each of these components to phenotypic variation in a specific population. Unlike molecular genetics, this research typically does not seek the causal mechanisms underlying the phenotype in question. Usually the combination of genes responsible for complex traits or behaviours has not been completely identified. Thus, behavioural genetics is statistically driven. The genetic study of humans must take advantage of naturally occurring genetic or environmental variation such as the birth of monozygotic or dizygotic twins or adoption.

First, let us consider whether behavioural genetics is separating nature and nurture by allocating contributions of each to any particular phenotype. Recall the Hebb analogy to the effect that nature and nurture is related in a similar manner, with respect to interdependence, as the length and width of a rectangle. If this is so, then how can nature and nurture be isolated and separately considered? The answer given by Plomin et. al. is that just as in any one rectangle, width and length cannot be separately considered (although, of course, they must be separately measured) when determining rectangularity, so too with any one individual, nature and nurture cannot be separated considered when determining phenotypical contributions. However, in a large population, statistical values for heritability may be attributed to nature and nurture as large population samples may reveal meaningful statistical variations. It must be understood, of course, that the quantitative comparison is relevant only to that specific population. Since genetic and environmental parameters apply to specific populations, no generalizations beyond those populations can properly be made unless and until many populations have been sampled and it has been demonstrated that the aggregated correlations hover within a narrow range (e.g. it would be interesting if most rectangles that were $100cm^2$ were long and thin rather than square).

Quantitative behavioural genetics assigns to a trait (e.g. intelligence) a quantitative heritability score between 0 (not heritable) and 1 (100 % heritable).[100] The numeral value represents the degree of genomic variance of a phenotype in each population sampled.[101] The method is useful in part because, while it is currently untenable to determine the genetic and environmental causes of most complex behavioural traits, statistical heritability is more easily determined when large population samples are evaluated. But this method might seem to be at odds with the biological method. Meaney points out:

[100] !00% heritability does not assure manifestation of a phenotype as other factors may intervene.

[101] Heritability' is a technical term used in biology, and may be defined as "the measure of the degree to which the variance of a particular phenotype is caused by genetic factors. It is given a value between 0 and 1 and effectively measures the extent to which offspring resemble their parents relative to the population mean". *Oxford Dictionary of Biology,* sixth edition (1985, 2008). 307.

> "Within the biological sciences, the mere statistical relation between a genomic variation and phenotypic outcome would not be considered as sufficient basis for the establishment of a functional link between the gene (or its product) and the relevant variation in phenotype. Such differences in perspective have led to rather lively debates between, for example, researchers in quantitative behavioural genetics and researchers examining the biological basis for individual differences in neural function.
> The issue becomes even more complicated when considering the interaction between gene and environment, since the statistical approaches to the study of Gene x Environment interactions are complicated and not yet fully developed."[102]

Biological sciences have different methodologies than behavioural genetics and different goals. While the statistical method used in behavioural genetics suits its purpose in determining statistical variation within a population, it would not suit biological sciences which seeks causation, but this difference in methodological approach does not negate the value of statistical analysis for behavioural genetics.

3.2.1. The Genetic Model-Twin Method

In assessing the contribution of genetics (versus environment) with respect to any phenotype, the twin method holds constant the environment parameter and allows the genetic factor to vary. For example, a study might compare phenotypical correlations of monozygotic and dizygotic twins, both groups living with their natural parents. The assumption then is that environment is held constant. To the extent that monozygotic and dizygotic twins differ phenotypically, the difference between the two, it is argued, must be due to the genetic difference and not environment.[103]

Although heritability is expressed as a probabilistic measure, it is in fact qualitative as discussed above. That is, the heritability score only gives an approximate sense of genetic effect. To see why this is so, it would be necessary to discuss heritability in detail which is

[102] Meaney (2010). 42.
[103] It is possible that the greater similarity of monozygotic twins is environmental. Since monozygotic twins are similar in so many ways, perhaps they are treated more similarity than dizygotic twins. But there is an assumption of roughly equal environments for both types of twins. If this assumption is not correct, then the effect of genetic influence would be inflated. But the equal environments assumption has been tested and appears to be valid for most traits. It is also possible that similar experience of monozygotic twins may derive genetically but this would not violate the equal environments assumption. Plomin et al. (2006). 81-82.

beyond the scope of this dissertation. Suffice it to say that heritability as a statistical measure of phenotypic variance is "a useful index of *approximately* how important genetic and environmental factors are to individual differences in a phenotype"[104] Even though GxE interactions are controversial in the calculation of heritability, the measure is nevertheless useful.

> "Fundamental to the study of human disease is the partition of total phenotypic variation in a population into genetic and environmental components… Despite its caveats, heritability is the single most useful measure of familial aggregation of disease..." .[105]

Paradoxically, heritability as currently calculated is both potentially misleading yet useful in some arenas. It is potentially misleading to give a quantitative heritability value to a phenotype when the measure is actually qualitative. And yet, it is nevertheless useful because it may provide information which can assist in the formulation of further research and policy.

3.2.2. Conclusion

Based on concerns raised above, there might appear to be ample reason to doubt the validity of studies using the methods employed by human behavioural genetics. Yet paradoxically, there is ample reason to give credence to the method. How can we reconcile this apparent paradox? Kelso might say that statistical variation and causation are complementary pairs. Molecular geneticists seek causal mechanisms because this is the focus of the discipline. Behavioural geneticists utilize statistical techniques because they do not seek causal mechanisms but rather quantitative measures of large populations. In this instance, these two are not in opposition. Rather, they are methodological approaches, each appropriate to their discipline, each with a set of caveats. Molecular biology limits its study to causal mechanisms. Therefore, within this discipline causation must be narrowly

[104] McGue, M. On-line course in Behavioural Genetics slides downloaded 8 August 2014.
[105] Tenesa, A.,and Haley, C.S. (2013). The heritability of human disease: estimation, uses and abuses. *Nature Reviews Genetics* 14(2). 139-49. doi: 10.1038/nrg3377.

construed to eliminate environmental effects. Behavioural genetics seeks statistical variation in large populations which is necessarily somewhat qualitative.

As a generalization, twin studies demonstrate statistically significant genetic contributions to phenotypes the closer the genetic kinship. How this is causally implemented is, in part, the study of epigenetics.

3.3. Epigenetics

For purposes of this chapter, I will consider epigenetics from the perspective of developmental psychology and molecular biology. I will show that the expression of the epigenome is contextually dependent and therefore malleable by environment, experience, and technology. Experience covers a vast range and includes interpersonal and social relations. Experience is but one aspect of the environmental context in which one is embedded. Taken together, experience and environmental context constitutes an ecology of sorts, hence the title of this dissertation. I will elaborate on these interdependencies in chapters 4 and 5.

In this section I briefly review the current state of knowledge as to how environmental factors, broadly construed, affect the expression of genes, specifically those which impact development and behaviour. I also review epigenetic research suggesting that contextually dependent modifications to the genome may, in some instances, be heritable.[106]

Epigenetic findings have broad implications not only for the formation and development of the brain but also for our understanding of how the mind is constituted. The discussion of the genome and epigenome also opens the door to the investigation in this dissertation of how multiple scales of complexity can modify the expression of the genotype and phenotype. These topics will be discussed in this chapter and chapters 4 and 5. For these purposes, it will be necessary, briefly, and simply, to describe the current understanding of the structure and function of the genome and epigenome.

[106] In the context of genetics, heritability refers to genetic transmission from parent to offspring. The heritability of environmental modifications to the genome might cause the worry that this is a fallback to the discredited doctrine of Lamarckism. It has become popular to incorrectly assume that Lamarck advocated the heritability of certain types of soft inheritance such as the shortening of the tail of a rat by scalpel. This was not Lamarck's position but rather a parody of his position by a detractor.

Epigenetics is a new and emerging subspecialty within the study of genetics. It is the study of the conditions and mechanisms that govern the expression or repression of gene function, specifically those modifications of the genome not affecting the sequence of DNA[107]. It specifically investigates those mechanisms by which biological and phenotypical properties are realized due to changes in environmental conditions without change in the DNA sequence. As with molecular genetics, molecular epigenetics studies the microscopic mechanisms. Epigenetic research is providing persuasive evidence that environmental factors play a significant co-causal role in the expression of genotypes and creation of phenotypes. But genes do not determine human phenotypes directly. Rather, they do so indirectly through the creation of (or failure to create) polypeptides (component of protein). For example, as discussed in the previous chapter, the disorder PKU is caused by the inability of the mutated PAH gene to create phenylalanine hydroxylase, an enzyme which metabolizes protein.

Epigenetics has significant implications for many allied areas of research such as developmental psychology, medicine, pathology, pharmacology, nutrition, and philosophy (among others), since it elucidates mechanisms of genetic adaptation and mutation that occur in response to moment to moment changes in the environment (including experience), or in the case of mutation, sometimes randomly. Orthodox genetic theory until recently taught that the genes one inherited determined characteristics in a rather rigid and inflexible manner. Epigenetics is demonstrating that this view is incorrect. Genes may be activated and deactivated in real time to produce or repress the production of proteins in response to the environment in which they are embedded. For purposes of this dissertation, the significance of my investigation of genetics and epigenetics is to demonstrate that even at the fundamental level of DNA, there is a two-way interaction---feedback and feed forward mechanisms (circular causality)--- amongst context, neurobiology, and genome. In the course of several chapters, I will show that bi-directional interaction is a recurrent theme that arises microscopically and macroscopically in DNA, neurons, the whole brain structure and function and in social interaction respectively. All this of course bears on the constitution of the mind since I will show that one interconnected web is formed from the most fundamental biological mechanisms (including

[107] Plomin et al. (2013). 417.

mind) to the broader social context[108]. This requires the philosopher of mind to think differently about mind. It should no longer be isolated from the body or the broader environmental context in which it is embedded but rather should be treated interdependently with these. For example, the brain-in-a-vat thought experiment fails to take account of the interdependence of mind, embodiment and contextual embeddedness. In order to duplicate the cognitive experience of an embodied mind, the envatted brain would have to duplicate the body and environment context.[109]

3.3.1. Epigenetic Biology

In this section, I will describe the interaction of environmental context and the epigenome. This will require a brief and simplified biological description of the genome and epigenome and how the latter may be modified as a result of signals from its environment.

Every stem cell in the human body has the same DNA sequence. Nevertheless, they differentiate into a variety of specialized types such as skin, liver, brain, or heart cells in utero and afterward. Differentiation is initiated, directed and accomplished epigenetically by the activation and deactivation of those genes required to create specialized cells. This process is known as epigenesis. The result of epigenesis is the synthesis of unique mixes of the proteins necessary for the creation of specialized cell types. In addition to differentiating stem cells into specialized cells, epigenetic processes are also involved in expressing or suppressing gene function in response to signals from other cells, the body, and the environment.[110] For example, stress may initiate a cascade of epigenetic, neurophysiological, and hormonal processes which affects the brain (and mind) and body interdependently (see section 3.6 which discusses stress).

Importantly, the multistep process constituting epigenesis is not initiated in the absence of a signal from the environment. In other words, the epigenetic process of manufacturing protein is due to the body's need based on environmental conditions in real time.

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[108] See Capra, F. (1996). *The web of life: A new synthesis of mind and matter.* London: Harper Collins.
[109] Cosmelli, D., Thompson, E. (2010). Embodiment or envatment? Reflections on the bodily basis of consciousness; in Stewart, J., Gapenne, O., DiPaolo. E. (2010). *Enaction: Toward a new paradigm for cognitive science.* Cambridge, Mass.: MIT Press. 361-386.
[110] Kandel, E. (2007). *In search of memory: The emergence of a new science of mind*. New York: Norton. 256-257.

Genes not only produce protein but also regulate the production of protein, that is, promote or repress production. If genes are not to be expressed, the process of uncoiling DNA does not occur. Jacob and Monad (1961) were the first scientists to provide evidence of regulatory genes and to show that they were responsive to environmental conditions.[111] They stated that genes are regulated by other genes; they distinguished effector genes and regulatory genes. Effector genes encode for proteins such as enzymes and ion channels whereas regulatory genes encode for regulatory proteins which activate or deactivate effector proteins.[112] Jacob and Monod discovered that when e. coli had a plentiful supply of the sugar lactose, bacteria activated a gene that encodes for the enzyme that breaks down lactose so that it is available for digestion. And when lactose is not present the gene that encodes for the enzyme is turned off by the presence of repressor protein on the promoter region of the gene.[113] Clearly the activation and deactivation of the gene that encodes for the enzyme must be highly responsive to its environment and is therefore exquisitely time and context sensitive. Thus, Jacob and Monod's research demonstrated that the transcription of genes is highly responsive to environmental conditions in real time. Contrary to the belief, still popular, that the genome determines biological function in a determinate manner, Jacob and Monod were the first to demonstrate that this is not the case.

A study using rats demonstrated that environmental conditions can sometimes trump genetic expression. In this research rats were bred with the abnormal 'agouti' gene which causes yellow coats and extreme obesity. One group of such mothers received methyl group rich supplements (folic acid, vitamin B12, betaine, and choline). The methyl group had previously been shown to effect epigenetic modification through a process known as DNA methylation. The mothers who were fed the supplement produced normal rat pups with brown coats and normal body morphology. The mothers not fed such a diet produced

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[111] Monad, J. and Jacob, F. (1961). Genetic regulatory mechanisms in the synthesis of protein. *Journal of Molecular Biology* (3). 318-356.
[112] Ibid; Kandel (2006). 257.
[113] Lactose is only broken down when glucose, which is preferred, is in low concentration or unavailable. Campbell, N.A. et al. Biology (2008). 351-356.

yellow pups which had voracious appetites and became extremely obese. The two sets of mice were genetically identical but differed in appearance due only to diet.[114]

In this experiment, environmental influence was able to repress epigenetic expression. As with PKU, nature (genetic expression) and nurture (diet) would appear to not interdependent but rather, loosely independent.[115] Without the intervention of diet, the agouti gene is expressed but with the diet, the expression of the gene is repressed. Diet and the agouti gene appear to be independently causal. What is unclear from the PKU and agouti research is whether in either or both cases, there is a middle ground according to which some, but not complete dietary modification results in milder rather than full blown symptoms. In any case, we are talking about a dynamic system according to which diet and the epigenome are attractors, the basins of which may vary to the extent one adheres to the dietary regime or veers from it.

The work of Jacob and Monod stimulated Kandel to wonder whether epigenetic changes were also implicated in learning and specifically, in memory. He asked himself, "What is the nature of the regulatory genes that respond to a specific form of learning, that is, to cues from the environment? And how do these regulatory genes switch a short-term synaptic change that is critical to a specific short-term memory into a long-term synaptic change that is critical to a specific long-term memory?"[116] He discovered that long-term memory required the synthesis of a new protein which was produced by epigenetic expression.

The significance of these experiments for my purpose is to demonstrate that the activation of genes that cause neurological establishment of long-term memory requires a specific type of environmental input that produces epigenetic changes. Analogous to Hebb's example of rectangularity consisting of the interdependence of length and width, creation of long-term memory requires the interdependence of the epigenome and the environment. Activation and deactivation of genes then is a highly dynamic and ongoing process in concert with experience in a specific context.

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[114] Lipton, B.(2005). *Biology of Belief.* Santa Rosa, CA.: Mountain of Love/Elite Books.70-73, Waterland, R.A., Jirtle, R.L. (2003). Transposible elements: Targets for early nutritional effects on epigenetic gene regulation. *Molecular and Cell Biology* 23(15). 5293-5300.

[115] There may, however, differences in these two cases. The PKU case is not a case of repression of epigenetic function but rather, diet is a compensatory mechanism to counter the lack of genetic function.

[116] Kandel (2006). 259.

Just as the creation of long-term memory requires environmental input to trigger the expression of the epigenome, environmental input may also hinder its creation by triggering the inhibition of epigenetic expression. One such influence is long-term or chronic stress (see section 3.6). Numerous studies have demonstrated the effect of stress on memory. High levels of stress have been shown to block long-term memory in pond snails (Lymnaea stagnalis). These snails have a nervous system like mammals and respond to stress similarly. Snails were trained to reduce the recurrence of breathing out of water by poking their breathing holes when they emerged from water to breath. Before and after training, the recurrence of attempts to breath out of water was recorded. Long-term memory was thought to be established when, after training, breathing out of water was reduced. After training, two types of stress were introduced, low calcium and overcrowding with other pond snails. When only one form of stress was introduced, long-term memory was reduced but short and intermediate term memory was intact. When both forms of stress were introduced simultaneously, all forms of memory were blocked. The experiment demonstrated the additive effects of stress which, at a threshold, may impair or even eliminate functional memory. Bear in mind that Kandel demonstrated that epigenetic changes only occurred when learning was imposed for an extended period of time. It is not the clear whether or not epigenetic repression was involved in the snail experiment because the length of time stress was imposed was not specified.[117]

3.4. The Nervous System

According to Francisco Varela, the nervous system is autonomous, that is, an operationally closed system. It is autonomous both with respect to the contextual environment in which it is embedded and with respect other somatic systems (although of course each somatic system may perturb the nervous system). Such perturbations may cause shifts in the homeostasis of the nervous system, either functionally or dysfunctionally, but the nervous system will maintain its self-organization within its range of tolerance. Why

[117] University of Exeter, "Stress makes snails forgetful". Science Daily, 6 November 2013. www.sciencedaily.com/releases/2013/11/131106202239.html. Accessed 6 November 2013; Dalesman, S., Hiroshi S., Morgan L.T., Lukowiak, K. (2013). Combining stressors that individually impede long-term memory blocks all memory processes". *PLoS ONE* 8(11). http://dx.doi.org/10.1371/journal.pone.0079561. Accessed 6 November 2013.

is this important? One approach to an answer is to contrast the nervous system as autonomous versus the predominant view of the nervous system as operationally open. In the operationally open system, the environment, in part, directs the organization. In this view, the system is both self-organized and environmentally organized. The move that Varela made was to view organization from the perspective of the organism rather than the observer. For the third-party observer, the organization of the nervous system can be conceived as both self and environmentally organized because, from that perspective, self and environment are conceptually distinct. But operationally, that is, from the perspective of the organism, self-organization and environmental impact are not separate. Rather, the nervous system adapts to perturbations (as a result of thermodynamic openness) as directed by its self-organization.

In this section, I briefly discuss salient features of the nervous system such as basic anatomy and neurophysiology and the reductive view of the nervous system according to which cognition consists of brain function. This is contrasted with the nonreductive schema according to which brain, body, and world constitute cognition. This latter view is put forward by enactivism. The reductive view, insofar as its focus is on neural structure and function alone, is methodologically useful but fails to take into consideration what I maintain is the constitutive role of embodiment and environmental context. A philosophical question is whether embodiment and contextual environment are peripheral (the reductive view) or constitutive (the non-reductive view). This question may be considered from an ontological or epistemological perspective according to reductionists. From the ontological perspective, cognition, *is* brain function (alone) and from the epistemological perspective, cognition is best *explained* by brain function. I am concerned with this question epistemologically. I believe that both perspectives are useful within the respective frameworks within which they operate. Since this dissertation is concerned with lived experience, enactivism and dynamic systems, the focus is on the expansive schema of brain-body-world.

From an evolutionary perspective, the nervous system has developed to mediate the relationship of the organism with the world as well as to mediate and coordinate many functions internally. Enactivism takes the position that, in mediating the relation with the world, the nervous system has a functional range within which it must operate; its 'domain of viability'. Yet within that domain, the nervous system is constantly active to maintain internal functions and to respond to both internal and external perturbations. For instance, stress is a perturbation that activates the hypothalamic-pituitary-adrenal (HPA) axis. This complex mechanism allows an organism to react to a potential threat to survival. When the threat is no longer present, negative feedback represses activation of the HPA axis and the nervous system returns to homeostasis. The functional dynamism may be modelled by dynamic systems. In this example, stress activates multiple somatic systems. If somatic systems are functioning well, that is, if their basins of attraction are deep, positive feedback operates to create an appropriate response and when the threat has ceased, negative feedback deactivates the HPA axis mechanism. But if the brain instantiates generalized anxiety, then its basin of attraction will be deep and the trajectory through phase space will veer toward that attractor. This trajectory would represent chronic activation of the HPA axis.

As Cosmelli, Lachaux, and Thompson say, the nervous system has "a domain of viability, of allowed functioning":

> "The nervous system is a complex dynamical structure, in which individual neurons have intrinsic activity patterns and cooperate to produce coherent collective behaviour… The explosion of neuroimaging studies in the last 15 years, as well as the substantial amount of data produced by electrophysiological techniques since the beginning of the 20th century, has shown that the brain is never silent, but always in a state of ongoing functioning… The nervous system has a domain of viability, of allowed functioning, but within this domain it explores a multiplicity of possible states in a recurrent, yet always changing manner... Incoming events are not sufficient to determine the system's behaviour, for any incoming event will change the system's activity only as a result of how the system, given its current activity, responds to that event."[118]

"Intrinsic neural activity patterns" implies autonomy of neural activity. Incoming events may change these patterns but only within its range of viability. If this range is exceeded, the system as a whole may be at risk.

"Cooperation of neurons " refers to aggregates of neurons, such as neural networks, that produce coherent collective behaviour. The activity of a single neuron is insufficient to convey meaningful information. Aggregates of neurons must meet two requirements: they

[118] Cosmelli, D., Lachaux, J.P., and Thompson, E. (2007). Neurodynamical approaches to consciousness; in Zelazo, P.D., Moscovitch, M. and Thompson, E. (2007). *The Cambridge handbook of consciousness*. Cambridge: Cambridge U.P. 732-733.

must act collectively and coherently. This suggests that meaningful information only emerges as a result of neural complexity. These are hallmarks of a complex, dynamic system. Note that as with all complex systems, emergence is a critical feature without which complex behaviour could not occur.

The nervous system is necessarily thermodynamically open, structurally coupled both to other organismic systems with which it coordinates function and to the environ, mental context in which it is embedded. Thus, the nervous system stands in the same position as the organism discussed in chapter 2 in the sense that both are organizationally closed and thermodynamically open. However, an important difference is scale. Nevertheless, the same conceptual tools for the analysis at many different scales.

3.4.1. Neuroplasticity

Here I explore neuroplasticity which may result either in healthy or unhealthy structural and functional neural modification. I draw out several philosophical implications of the fact that the brain adapts structure and function based on experience. These include top-down control of neural function, circular causality, application of dynamic systems theory and interdependence of body, mind and environment. This examination will include the findings of neuroscientific research as to the extent to which the brain is plastic both in physical activity such as constraint-induced movement therapy (discussed below) as well as in purely cognitive activity such as meditation (also discussed below).

I argue that the brain functions hierarchically, each scale with its own rules, and that property emergence is an important feature; higher scale emerging from lower. The extent to which higher scales constrain lower scales may, in part, be a matter of focused attention, intention, and effort, in other words, top-down constraint. By persistent, effortful attention, lower level features of brain (and mind) function can become increasingly constrained by higher conscious levels. One mechanism by which this occurs is neuroplasticity. Structurally, new neural connections are created, and existing synaptic connections are strengthened which strengthens top-down control. One implication, (certainly controversial with respect to free will) is that one may, by one's own effort, increasingly structure one's thoughts, beliefs and emotions according to one's own intentions, thereby demonstrating an increasing degree of free will. Conversely in the extreme, if one minimizes wilful control of cognitive activity, one minimizes top-down control and thereby, limits one's degree of free will.

The term 'plasticity' was first used by the psychologist William James in 1890 to refer to the fact that "organic matter, especially nervous tissue, seems endowed with a very extraordinary degree of plasticity".[119] However, the eminent Spanish neuroanatomist Santiago Ramon y Cajal declared in part,

"In the adult centers the nerve paths are fixed, ended and immutable."[120]

It was the later opinion which has prevailed until recent times. A significant development in the change in the understanding of neuroplasticity occurred as a result of the invention of functional magnetic resonance imagery (fMRI) in 1990s. FMRI has been used in research to study the correlation of neural activity and cognitive tasks assigned in experimental design.

Neuroplasticity is the ability of the brain to modify structure and function in response to context and experience. It had been known, of course, that this is what happens in the case of learning. What had not been known until more recently is the extent to which and circumstances under which the brain can change structure and function.[121] This encompasses both physical and mental experience.[122] For example, with regard to physical experience, Edward Taub, et al. have demonstrated that a person who has had a stroke that disables an arm may, under certain circumstances, be able to regain function by immobilizing the functional arm while continually attempting to use the non-functional arm. Taub called this constraint-induced movement therapy (CIMT). Neuro-imaging has demonstrated that the area of the brain initially responsible for movement of the arm

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[119] Begley, S. (2008). *Train the mind change the brain.* New York: Ballentine Books 5 quoting James, W. (1983). *Principles of Psychology*, Cambridge, Mass.: Harvard University Press. 110.

[120] Ibid.quoting Teter, B., and Ashford, J.W.(2002). Neuroplasticity in Alzheimer's disease. *Journal of Neuroscience Research* 70. 402

[121] MIT researchers have demonstrated that neuroplasticity in new-born ferrets is responsible for the ability to recruit the auditory cortex to perform visual functions. Schwartz, J., and Begley, S. (2002). *The mind and the brain.* New York: Harper Collins. 101-103.

[122] Strictly speaking, the distinction between physical and mental experience is artificial. Clearly, every physical experience has a neurological component. Furthermore, it seems equally clear that every mental or cognitive experience has a physical component.

remains non-functional but that an adjacent area has been recruited to regain function. By repeated attempts to use the disabled arm, the brain is reorganised, that is, new neural connections to a functional portion of the brain are established to make the arm functional once again.

CIMT is philosophically significant for several reasons. The first is that it demonstrates that attention, intention, and repetitive conscious effort, higher level cognitive functions, can act "downwardly" to reconfigure the structure and thereby the function of the brain. Cognitions arising from attempts to use the affected arm are an example of "upward causation". For example, some success in moving the affected arm might lead to optimism about the chances of recovery which might then lead to more attempts to use the arm. It would however be more proper to consider upward and downward causation as an example of bi-directional or circular causality since the intent to use the affected body part necessarily is coupled with the actual effort and the success which leads to optimism then fosters continued efforts. Bi-directional causation is a feature of the enactive approach. In this hypothetical, CINT demonstrates mind-body interdependence.

In dynamic systems terms, attention to movement, continuous determination to use CIMT, amount of actual therapy accomplished, nature of the lesion and other comorbidity factors are a few of the most obvious control parameters. Presumably, as a general rule, the more one does CIMT on a continuing basis, that is, the deeper the attractor basins of intention, determination and actual practice of CIMT, (assuming other comorbidity factors are negligible, i.e. very shallow attractor basins), the more likely progress toward a successful outcome as represented by a trajectory through phase space. However, deeper basins of attraction of comorbidity factors and shallower attractor basins in the amount of therapy practice, will most likely result in diminished neuroplastic effect (poorer recovery outcome). This would be represented by a trajectory through phase space that deviates from the ideal.

The second philosophically interesting point, related to the above, is that multiple scales of hierarchical cognitive function are involved recursively; somatosensory function is a lower-level function in the case of CIMT and intention, attention, and conscious effort are higher-level functions with interlinked neural circuits which act interdependently in a co-ordinated manner. Multiple components of this complex system are modelled well by dynamic systems theory. Finally, it is notable that in this situation, the brain is changing structure and function in accordance with its own Self-organizing mechanisms. Merzanich et. al. have summarized these conclusions as follows:

> "A large body of science has now shown that our expressive behaviours are a product of complex, multilevel recurrent networks. In these networks, information is represented with greatest resolution in detail in place, feature, and time at the lowest network (system) levels. At successively higher levels, there is an integration of representation to progressively more complex objects, relationships and actions, as they apply in the "real world." At the "top" of brain systems, those most-completely-integrated neurological representations generate enduring neural activity that is selective for their representation… Representational information is continuously fed backward from this highest (and from all other) levels. It is important to understand that in these recursive recurrent networks, the operational levels contributing to the representation of any aspect of input or action in brain systems are inseparable; in other words, all explicit behaviours are a product of the system"[123]

These features have since been demonstrated clearly in the rehabilitation of impaired function. Because the operational scales are integrated and inseparable, (a bi-directional, recursive, time sensitive relationship) to address only that scale which appears to present a symptom or problem is only partially rehabilitative. That approach assumes that operational levels are modular and separable which clearly is not the case. Rather, a systems approach is required in which all operative levels of function are addressed. Merzenich et al. again:

> "It should be noted that cognitive therapists and other rehabilitation specialists have usually focused exclusively on training explicit, obviously impaired behavioural abilities. If an individual has an evident failure in memory, for example, the therapist most often engages the patient to practice remembering, or to develop compensatory strategies to help them work around their memory loss. By contrast, from a more neurological perspective, we focus on improving the many deficits across the various system levels that contribute to the degradation of the neurological representation of information that the patient is struggling to record. Going back to the memory failure example, the focus of neuroplasticity-informed training would be on the clarity, in neurological terms, with which they represent that information, the suppression of distractors that disrupt remembering, the baseline levels of attention that support all epochs of remembering (among others),

[123] Merzenich, M., Nahum, M., Van Vleet, T.M. (Eds.) (2013). *Changing brains: Applying brain plasticity to advance and recover human ability*. Amsterdam: Elsevier. 142.

> all aimed at improving the different operations of the relevant brain network before re-exercising explicit memory abilities themselves."[124]

Enactivism is the appropriate philosophical basis to ground this systems-based approach to understanding the operation of the brain since it recognizes bi-directional causality, utilizes dynamic systems theory, recognizes the interdependence of brain, body and environment and has its basis in the Self-organization of the nervous system. Dynamic systems theory is a useful tool for modelling neural function because it employs multiple attractors at different hierarchical scales of operation that may vary in basin depth from moment to moment. The brain-body-world schema recognized by the enactive approach is necessary when considering organismic embeddedness. In the case of CIMT for example, it is not sufficient to analyse only neural function. Rather, the therapy requires engagement with the world which is not peripheral but rather constitutive.

As for age, it is now clear that neural structure and function is plastic for as long as one is alive, but the extent of plasticity does seem to vary with age. For example, if a child has a hemispherectomy before the age of 4-5, where one half of the brain is removed, they may still have most mental function, but may suffer the loss of some peripheral vision and fine motor skills. The remaining hemisphere is able to perform functions normally performed by the missing hemisphere because at this young age neurons are remarkably plastic. However, if a brain injury causing damage to language areas occurs after ages 4-6 then the child may have a serious language deficit.[125]

In this example, DST may be employed to describe and explain the recovery of function, that is, the behaviour of the neurological and associated systems. Age is a critical factor in the recovery of function in this instance. In the parlance of dynamic systems, the age of the child is reflected in the depth of the basin of attraction. For example, if the is newly born, the brain is highly plastic. The depth of the basin of attraction would be deep indicating its ability to recover from a hemispherectomy. If additionally, the young child is provided with an enriched environment which facilitates language skills, the brain is more likely to recover greater language function.

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[124] Ibid. 142-143.
[125] Ibid. 96-100.

From the enactivist perspective, the ability of the infant to recover function after a hemispherectomy demonstrates the interdependence of brain, embodiment and environmental context. Environmental embeddedness and stimulation initiates a cascade of effects which, under certain conditions, activates epigenetic expression which then triggers the complex process under which protein is created that is instrumental in the structural and functional neural change. Here also the interdependence of *nature*, (i.e. the genome and brain) and *nurture* (i.e. environmental stimuli) are demonstrated.

Interestingly, the brain is not only plastic with regard to physical experience. It also appears to be modifiable by mental function, for example, mental imagery. According to one definition, mental imagery refers to

"representations and the accompanying experience of sensory information without a direct external stimulus".[126]

Typically (but not always) mental imagery is used to visualise an activity in which one has previously engaged. For example, athletes might use mental imagery to visualise aspects of performance in their sport. It has been demonstrated that some of the same areas of the brain are active when one is engaged in mental imagery such as visualising a motor control activity as when one is physically engaged in that same activity.

> "Brain imaging work has provided compelling evidence that visual mental images arise from activation of the same types of visual features that are activated during visual perception. Several studies have explicitly modelled the representations encoded in activity during perception and then used the model to decode mental images from brain activity".[127]

This would suggest that perception and mental imagery share a significant quantity of common neural activation patterns. This might provide a possible explanation as to why meditation (using mental imagery), as with perceptual experience, has neuroplastic effects.

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[126] Person, J., Naselaris, T., Holmes, E. and Kosslyn, S. (2015). Mental imagery: Functional mechanisms and clinical applications. *Trends in cognitive science* 19(10). 590-602 ;590

[127] Ibid. 592. Shephard and Metzler have demonstrated that various features of mental images such as 'mental rotation tasks' correlate with features of real-world tasks such as rotating a corresponding real-world object. Thanks to Joel Walmsley for making me aware of this research.

Environmental factors are responsible for modifications to the synapses, either strengthening or weakening specific synapses. Strengthening synapses is a result of repeated activation via usage which results in the creation of more vesicles in a particular axon (and more axons or dendrites with more vesicles and synapses) which release more neurotransmitter ions. Weakening of synapses is due to the deactivation due to non-use and perhaps eventually (depending on circumstances) pruning of unused axons, dendrites or neurons. It is clear that neural plasticity is a highly adaptive neural mechanism which, in response to the needs of the organism, in its interaction with the environment, creates and strengthens or weakens neural circuits on an ongoing basis. Conversely those neural connections less utilized are pruned.

Recall that in the previous chapter, I said that environmental perturbations and internal dynamics may require an organism to adapt in order to maintain functional integrity. It does this through looped feedback at multiple scales, coordinated by the nervous system. I gave the example of stress as a mechanism to which the brain and body dynamically adapted through numerous feedback loops. Now I will discuss stress as a pervasive influence, to which the genome and brain respond through looped feedback at multiple scales.

3.5. Stress

As stated above, stress is a significant perturbation to which the nervous system responds by means of its Self-organization as a closed system.

> "…[O]perationally, the nervous system is a closed network of interacting neurons such that a change of activity in a neuron always leads to a change of activity in other neurons, either directly through synaptic action, or indirectly through the participation of some physical or chemical intervening element..." [128]

This description follows the understanding of autopoietic organisms discussed in chapter 2 according to which an autonomous organism defines the cognitive domain in which it operates. Recall that autonomy refers to Self-organizing dynamics of an organism or

[128] Varela, F. (1979). *Principles of biological autonomy.* New York: Elsevier. 242.

system. However, as a component within the organism which, in turn, is embedded in the environment, the nervous system modulates the perturbations (internal or external) to which the organism is exposed, one of which is stress.

Hans Selye defined stress as "the nonspecific response of the body to any demand".[129] The term 'nonspecific' refers to the biologic responses, which are the same in all forms of stress, regardless of the source. It may be surprising that even a joyful event may elicit the stress response according to Selye. He believed that both eustress and distress utilise organismic energy, thus both fall within his definition of demand.

Demand refers to the specific burden with which the organism is confronted, regardless of whether, in common parlance, it is positive or negative. Stress may take a physical, emotional, or psychological form or it may take a form which is a combination of more than one (for example, of social stress). Physical stress is constituted by a physical burden imposed on the body. Emotional and psychological stress may be described as a stress imposed on the mind. Stress may be acute or chronic. It may be positive (eustress) in the sense that it may serve survival as, for example, when one is fleeing a predator. Or it may be negative (distress), when, for example, a traumatic event initiates a process referred to as post-traumatic stress disorder (PTSD). From the enactive perspective, response to stress demonstrates the interdependence of mind-body-environmental context. For instance, emotional stress may have a somatic effect and *vice versa*. The result of this interdependence is that stress may cause a brain-body recursive feedback loop both in acute and chronic stress.

The HPA axis describes the neural and somatic organs and mechanisms which create the "fight or flight" stress response, the body's adaptation to life threatening situations, either real or perceived. When functioning properly in the situations for which it was evolutionarily intended, it is a valuable survival mechanism. Feedback processes initiate the stress response when needed and terminate it when no longer necessary.

Chronic stress may lead to widespread neural and somatic effects. For example, cortisol blocks perceptual learning in humans by affecting hippocampal memory function. At the genomic level, chronic social stress has been found to upregulate the expression of genes related in inflammation and consequently, downregulate genes related to antiviral response

[129] Selye, H. (1976). *Stress in health and disease.* Boston: Butterworths. 15.

in mice. But stress not only affects simple organisms neurologically and epigenetically but may also affect humans similarly. There is some evidence that chronic social stress both in mice and humans causes an inflammatory response (leading to increased risk of disease) via the expression of pro-inflammatory genes and suppression of genes involved in antiviral responses.[130] Circular causality is once again evident. Researchers have demonstrated that brain function responsible for regulating stress response intertwines with elements at three scales: genetic, neurological, and behavioural. They concluded:

> "… that vulnerability to stress is not only related to a predisposition due to a certain gene. The relevant gene can be expressed or not expressed according to a person's experience, environment and many other context-related factors".[131]

In their research, measurements of microRNAs (micro RNAmiR-29c), believed to have a regulatory effect on stress, were obtained by blood sample before and 3 hours after induced stress. FMRI images of the brain were also taken during the period of stress. Twenty minutes after induced stress ended, participants were divided into two groups, those who continued to suffer stress or took a long time to recover (Sustainers) and those who recovered quickly (Recoverer). A specific alteration in the expression of microRNAmiR-29c was greater in Sustainers and corresponded with modified connectivity of the vento-medial prefrontal cortex, a major stress regulation node of the brain.[132] The experiment provides evidence of the connectivity of the epigenome and neurological systems and lends support to the theory that both need to act interdependently and in a coordinated manner to sustain prompt recovery from stress.

Philosophically, this experiment demonstrates the interdependence of brain-body-world schema which is foundational to enactivism. The three scales operate dynamically and recursively. It is impossible to pinpoint one scale as more significant than the others. Rather, whether one is a Sustainer or Recoverer is a product of the brain-body-world

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[130] Powell, N.D., et al. (October 8, 2013). Social stress up-regulates inflammatory gene expression in the leukocyte transcriptome via β-adrenergic induction of myelopoiesis. *PNAS* 110(41). 16574-16579. https://doi.org/10.1073/pnas.1310655110.

[131] American Friends of Tel Aviv University. Targeting the mind-body connection in stress: Researchers combine genetic testing and brain imaging to determine vulnerability to PTSD. *Science Daily*. www.sciencedaily.com/releases/2016/02/160204111636.html. Accessed 4 February 2016.
Vaisvaser, S. et al. (2016). Neuro-epigenetic indications of acute stress response in humans: The case of MicroRNA-29c. *PLoS One* 11(1).http://dx.doi.org/10.1371/journal.pone.0146236. Accessed 4 February 2016.

[132] Ibid.

complex dynamic system. Assuming that factors at all three scales of brain, body and environmental context are control parameters, one could intervene, in principle, at any one of the scales to modify stress response. Intervening with stress reduction techniques for example would, in principle, positively affect the epigenome, brain and behaviour. Stress reduction techniques may modify the depth of the basins of attraction of factors at the epigenetic, neurological, psychological and somatic scales. Repetitive practice of stress reduction techniques would be necessary to change the trajectory of the system. The phase portrait would likely be modified significantly only by recursive, bidirectional feedback loops.

There is also evidence that epigenetic changes resulting from experience of stress may, in some instances, be heritable. For example, an experiment conducted by Meaney demonstrated the importance of lack of nurture on infant rat pups and provided some evidence these effects were heritable. Rat pups raised by neglectful mothers and deprived of significant licking and grooming grew up nervous, fearful, timid and stressed. In turn, when these mistreated rats gave birth, the pups they raised were of the same temperament. But rat pups raised by dutiful mothers who provided significant licking and grooming matured into well-adjusted rats, willing to explore new environments and able to cope well with stressful situations. And when these latter rats gave birth and raised pups, the young ones had the same temperament as the mothers. Licking and grooming behaviour in rat pups increases a transcription factor that increases the production of glucocorticoid receptors in the hippocampus. An increase in glucocorticoid receptors acts as a negative feedback mechanism; more glucocorticoid receptors correlates with decreased levels of fear, timidity, etc. Quantity of glucocorticoid receptors are heritable, although not necessarily permanently.

Conversely, when a rat pup born of a fearful mother is raised by a well-adjusted mother rat, the pup becomes well-adjusted also. And when a pup born to a well-adjusted mother is raised by a fearful mother the pup becomes fearful. The study suggests not only that epigenetic changes may be inherited but also that they may be reversed, to some extent, by appropriate behaviour.[133]

[133] Begley, S. (2008). *Train your mind change your brain.* New York: Ballantine Books. 163-175; see also Lipton (2005 70-73.

The heritability of epigenetic changes caused by stress is a controversial topic for a couple of reasons. Generally epigenetic changes are not stable, so it is believed that, for the most part, they are not heritable. Also, the heritability of acquired characteristics is associated with the discredited theory put forward by Lamarck. Nevertheless, there is now some evidence that certain acquired characteristics can be inherited. This is another instance, which, if substantiated, demonstrates the interdependence of epigenome, embodiment and environmental context.

What is true for pond snails and rats may be true for humans as well. Adverse environmental circumstances may cause negative behavioural, neurological and (probably) epigenetic modifications.

In children, the damaging effects of deprived care and lack of stimulation have been observed. In 2005, a University of Wisconsin study was published of Romanian and Russian children placed in orphanages and extremely neglected. Children deprived of care and stimulation from 7 to 42 months suffered attachment disorder and a dearth of oxytocin and vasopressin, both related to lack of ability to attach (see section 4.3., in which I discuss infant-caregiver attachment). The children were adopted by American families and in the Wisconsin study 18 such children were brought together. Whereas in the control group of 'normal' children cuddling with a parent raised the levels of oxytocin the same treatment did not raise the oxytocin levels of the stimuli-deprived children, suggesting their inability to bond.[134] Although the research did not report on epigenetic effects, it is fair to speculate that the dearth of oxytocin[135] and vasopressin in neglected children was a combined epigenetic and neurological effect. In Chapter 4, I discuss in some detail the parent-child relationship and the effect of parental attachment styles on the child.

[134] Begley (2008). 178-182; Fries, A.B., Ziegler, T.E., Kurian, J.R., Jacoris, S., Pollak, S.D. (22 November 2005). Early experience in humans is associated with changes in neuropeptides critical for regulating social behaviour. *Proceedings of the National Academy of Sciences* 102*.* 17237-40.

[135] The oxytocin peptide is synthesized as a precursor protein from the *OXT* gene. One may speculate that lack of oxytocin production may result, at least in part, from epigenetic downregulation of the cursor protein. "There is first evidence that *OXTR* methylation is associated with autism, high callous-unemotional traits, and differential activation of brain regions involved in social perception. Furthermore, psychosocial stress exposure might dynamically regulate *OXTR*." Kumsta, R., Hummel, E., Chen, F.S., and Heinrichs, M. (2013). Epigenetic regulation of the oxytocin receptor gene: Implications for behavioural neuroscience. *Frontiers in Neuroscience* 7. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3661945/pdf/fnins-07-00083.pdf.

These results suggest that a failure to receive species-typical care disrupts the normal development of the oxytocin and arginine-vasopressin systems in young children. Perturbations to these systems may interfere with the calming and comforting effects that typically emerge between young children and familiar adults who provide appropriate care and protection. Importantly, at the time of testing, children had experienced an average of 3 years of rearing in relatively stable, enriched, and nurturing family environments. However, this environmental change did not seem to have completely overridden all the effects of early neglect. Consistent with these data, children reared in institutionalized settings, and other psychologically neglectful environments, often experience problems in social development that persist even after children settle into family environments. However, it is critical to note that not all children who experience early neglect develop the same kinds of problems, and children with lower hormonal reactivity may, over time, develop satisfactory interpersonal relationships.

> **"**There are potentially important individual differences operating across both the previously neglected and control groups of children. Therefore, future studies should seek to address this issue by relating detailed aspects of the early environment to longitudinal outcomes and determine the degree of plasticity in these systems. The current experiment cannot address questions concerning the direction of influence between social difficulties and alterations in this biobehavioural affiliative system. Nonetheless, the present data provide a potential explanation for how the nature and quality of children's environments shape the brain-behavioural systems underlying complex human emotions. These findings not only inform understanding of normal human development, but will hopefully foster the development of targeted interventions for children exposed to environmental risks."[136]

This study did not seek to understand the factors in the neglected children that accounted for the differences in ability to socially adapt. Since the opportunity to examine a large group of children deprived of species-specific care is severely limited, this remains an open question.

The fact that there is a difference in the ability of children who have suffered neglect or abuse to socially adapt suggests that there is most likely a variety of biological (perhaps both epigenetic and neurological) and environmental factors which interdependently bring about

[136] Ibid. 17240.

their circumstance. This suggests that DST may serve to model and explain this result. For example, if a child has a genetic or epigenetic predisposition to greatly suffer the effects of stress, the basin of attraction of this factor would be deep and the trajectory through phase space would veer toward this attractor.

Disturbingly, there is some evidence that the effects of stress may be heritable in humans. And it supports the belief that epigenetic changes may occur because of stress. Yehuda and Bierer studied the prevalence of post-traumatic stress disorder (PTSD) in adult children of Holocaust survivors who have not themselves been traumatized but whose parents have suffered PTSD. Two groups of adult children of Holocaust survivors were compared; one group had parents who suffered PTSD and the other group had parents who did not suffer PTSD. The researchers found that the group whose parents had PTSD had lowered 24-h mean urinary cortisol excretion and salivary cortisol levels as compared the control group when both were exposed to dexamethasone, a stress inducing substance. Lowered cortisol levels are associated with the presence of chronic stress. They concluded that there may be increased risk of PTSD in children whose parents have suffered PTSD. Of course, this result does not indicate that the stress in the adult children was epigenetically transmitted at birth since post-uterine exposure to stress from parents also was possible. Likewise, it is possible that stress was not epigenetically transmitted in the case of rats who failed to receive sufficient licking. Arguably environmental influence may have accounted for both results. However, according to these researchers, additional evidence that stress is epigenetically transmitted may be gleaned from other studies that found an increased risk for the development of PTSD in monozygotic twins as compared to dizygotic twins both in combat veterans and population-based studies of civilians.[137] And New York City mothers pregnant on 11 September and who suffered PTSD demonstrated low cortisol levels that also appeared early in the in-utero development of the infant.[138] Again, these studies do not prove epigenetic inheritance of stress as genetic predisposition rather than epigenetic changes may be responsible. It has been suggested that the aggregation of these studies suggesting epigenetic heritability does add weight to the view that in some instances,

[137] Perhaps this is evidence that there is a genetic rather than an epigenetic component to the disposition to develop PTSD.
[138] DeKloet, E.R., Oitzl, M.S., Vermetten, E. (Eds.). (2007).Transgenerational transmission of cortisol and PTSD risk. *Progress in Bain Research* 167. 121-135; 122.

epigenetic expression and repression is heritable. This too is controversial. But in order to establish the heritability of epigenetic expression and repression more firmly, molecular epigenetics must either demonstrate that epigenetic mechanisms are causal or that these mechanisms are very strongly correlational across a wide range of experiences.

One experiment has provided some evidence that a brief period of meditation, that is, mental activity[139], may also produce epigenetic changes. This is another piece of evidence that suggests "downward causation" that is, mental activity may cause physical effects. Experienced meditators practiced mindfulness meditation for 8 hours day.[140] This practice previously has been shown to bring about neural, behavioural, and biochemical changes, although the mechanisms have not been understood. In this experiment, a group of 19 long-term meditators with an average of 6240 lifetime hours and a control group of 21 non-meditators were participants. The members in both groups had similar profiles (age, gender, race, body-mass index). The meditators engaged in intensive mindfulness meditation practice while the control group engaged in such leisure-time activities as reading, walking, playing computer games or watching documentaries in the same environment as the meditators for the same period. Before and after their respective activities, blood was drawn from all participants, and levels of genes associated with proinflammatory response were determined for both groups before and after their respective activities. Chronic low-level inflammatory response is associated with the most common health problems such as cardiovascular and metabolic disease, cancer, and neuropsychiatric disorders.[141] Before their respective activities the level of such gene expression in both groups was approximately the same but after the respective activities the group of meditators demonstrated rapid changes in the levels of genetic expression of key epigenetic modification enzymes which facilitate the decrease in the activity of proinflammatory genes.

The upshot is that meditation appears to positively affect genetic expression, increasing the ability of long-term meditators to better cope with stress. This conclusion was bolstered by another test done in this same experiment. Both groups were administered the Trier

[139] There is the argument that meditation is not purely mental since many types of meditation rely on cognitive reflections of lived experience. Also, meditators are usually directed to maintain certain bodily postures. Thus, contextual experience and embodiment are important in meditation.
[140] Kaliman, P., et. al (2014). Rapid changes in histone deacetylases and inflammatory gene expression in expert meditators. *Psychoneuroendocrinology* 40. 96-107.
[141] Ibid. 105.

Social Stress Test (TSST) twice; T1 (just before the beginning of the experiment and T2 (afterward). Cortisol levels were determined for each. The meditators demonstrated more rapid lowering of cortisol levels indicating faster recovery from stress only after meditation. And faster recovery of cortisol levels was correlated with lower gene expression levels of the proinflammatory genes. Thus, there is evidence that the mechanisms by which mindfulness meditation reduces stress and promotes faster recovery from stress are epigenetic in nature.[142] And since many diseases are associated with inflammation, meditation also may be a useful intervention or prophylactic for a large variety of medical conditions. This study did not attempt to study individuals who might have been predisposed to stress. Since the purpose of the test was to examine the effect of meditation on individuals, the predisposition of those individuals was kept invariant (a more complete discussion of meditation may be found below, section 3.7. and chapter 6).

It is worth noting that this study suggests that meditation does not eliminate stress but rather enables one to be more resilient after having experienced stress. In other words, meditation affects the time lapse between the onset of stress and recovery. Comparing phase portraits (plotting stress and recovery time) of those who meditated and those who were controls would show the resiliency benefits of meditation.

This experiment provides evidence that meditation has a positive effect on multiple scales; epigenetic, biochemical and behavioural. In DST terms, the depth of the basin of attraction of meditation is related (presumably) to the length and regularity of meditative practice (number of meditation practice hours).

The mechanisms by which epigenetic expression and repression operate are not completely understood but one experiment provided some insight. It also suggested the mechanism by which epigenetic expression and repression may be transferred to future generations. In this experiment on drosophilae, ATF2, a member of a family of transcription factors which regulate gene expression in response to changes in the cellular environment, was implicated in the epigenetic mechanism. Apparently, ATF-2 plays a role in silencing certain genes when there is no stress. But when stress exists, ATF-2 changes its function and induces gene expression on a form of chromatin that is epigenetically heritable. The result for future generations is enhanced response (increased vulnerability) to stress. These

[142] Ibid. 104.

findings provided the first evidence of multigenerational transmission of stress-induced epigenetic change, highlighting the role played by ATF-2.[143]

This research suggests that certain cultural influences could be transferred to future generations. This view, which has been associated with the discredited doctrine of Lamarckism, needs to be cleansed of the associated stigma and researched with "fresh eyes" using the tools now available to molecular and systems biology and dynamic systems theory.

I have presented a brief summary of epigenetic research designed to demonstrate the interdependence of epigenetic expression or repression, neural and psychological impact and stress. In all cases, circular causality is demonstrated. Stress and low-level inflammatory response has been implicated in a variety of illness and diseases. Understanding how to moderate the stress response, particularly in chronic stress is not only philosophically significant but medically important.

3.6. Meditation

Above I discussed meditation as an example of a practice which can affect epigenetic expression and neural plasticity. Now I discuss meditation in greater detail to show its impact on neural structure and function.

Research into the neurological impact of meditation is still in its infancy although many studies have been conducted. Long-term longitudinal studies have yet to be performed. And, a meta-analysis[144] of a portion of these has concluded that, in many cases, methodology was below an acceptable standard, so care must be taken in evaluating claims. Nevertheless, preliminarily, there is strong evidence that meditation is correlated with top down neuroplastic effects.

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[143] Riken (2011). Mechanism for stress-induced epigenetic inheritance uncovered in new study. *ScienceDaily*. Accessed 2 December 2019 from: www.sciencedaily.com/releases/2011/06/110623130328.html.
Seong,K-H., Li, D., Shimizu,H., Nakamura,R., Ishii, S. (2011). **Inheritance of stress-induced, ATF-2-dependent epigenetic change**. ***Cell*** 145 (7). 1049-1061.
https://www.cell.com/cell/fulltext/S0092-8674(11).00590-3?_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0092867411005903%3Fshowall%3Dtrue.

[144] Goyal, et al.(2014). Meditation programs for psychological stress and well-being: A systematic review and meta-analysis. *JAMA Intern Med* 174(3). 357–368; doi:10.1001/jamainternmed.2013.13018.

The term *meditation* has been used to refer to a variety of mental experiences but here the term is used to refer to a broad range of mental techniques, the purpose of which is to affect cognitive changes, the nature of which depends upon the technique utilized. In other words, it appears to be the case that the nature of the neuroplastic change is correlated with the type of meditation employed. This makes sense as the nature of neuroplastic change arising from perceptual experience would also vary with the nature of that experience. The experienced meditator varies the form of meditation practiced in accordance with their desired outcome; to shape the mind in accordance with their goal. For example, a meditator who wishes to increase unconditional compassion might perform a form of lovingkindness meditation.

In this chapter, I am referring to three specific types of meditation taken from Buddhist practice: mindfulness meditation[145] (referred to in Buddhism as *śamatha*, translated as calm abiding or quiescence), open monitoring meditation (OM),and compassion meditation. In the former, one focuses lightly on a specific object, say the breath, with the intention that the mind should remain focused there. When one becomes aware that the mind is no longer focused on the breath, that is, the mind has wandered, one brings awareness gently back to the breath. In this practice, cognition can be divided into awareness (i.e. awareness of breath), metacognition (awareness of where awareness is placed at each moment), and mental activity moment to moment which arises involuntarily and may vary widely between thoughts, emotions and images, etc. Intention also plays a significant role as it is the mental factor which orients the whole practice. One sets the goal to remain constantly aware of where attention is directed at each moment. One's dispositional attitude should be non-judgmental and indifferent to whatever cognitively arises. Metacognition is also employed to monitor dispositional attitude. This is a beginning practice designed to stabilize awareness so that mind wandering is diminished and ideally eliminated altogether in the long-term. It is said that this practice creates a 'gap in time' between one's thoughts and emotions and one's behaviour. This gap allows for greater emotional and cognitive control since evaluative judgement may enter the gap. One result, as we have seen in section 3.6 is to gain greater resiliency in stressful situations.

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[145] *Śamatha* meditation has been shorn of its Buddhist roots and popularised in the West by John Kabat-Zinn who has introduced it as mindfulness-based stress reduction (MBSR). Transcendental meditation, a form of mantra meditation, has popularized in the west by Maharishi Mahesh Yogi.

OM builds on the stability of attention developed in mindfulness practice. Rather than focusing on a specific object, attention is directed inwardly to cognitive and somatic experience, that is, awareness of whatever mental or somatic content arises moment to moment. No attempt is made to suppress, follow or evaluate the content of experience. Rather, the meditator is directed to observe it "without grasping", to remain indifferent and non-judgmental to it. Importantly, one is required to hone the ability to 'stand aside' from such content, not identify with it nor lose the perspective of 'indifferent observer'.[146] When one's attention drifts or one realizes that she is no longer nonjudgmentally observing mental and somatic experience (i.e. metacognition has not been operative), one returns to non-judgemental observation.

> "A central aim of OM practice is to gain a clear reflexive awareness of the usually implicit features of one's mental life. It is said that awareness of such features enables one to more readily transform cognitive and emotional habits. In particular, OM practice allegedly leads one to a more acute but less emotionally reactive awareness of the autobiographical sense of identity that projects back into the past and forward into the future. Finally, heightened sensitivity to body and environment occurs with a decrease in the forms of reactivity that create mental distress".[147]

In compassion meditation, one begins by focusing attention on someone they love or who loves them. One allows the feeling of love and compassion toward that person to develop until compassion fills the mind. For the novice, it is likely that one's mind will wander. Metacognition regulates the wandering mind and bring the focus back to all-consuming compassion. Next, one releases the focus on the individual who was used to evoke love. One remains in that state of compassion with no focus or rather, with focus on all sentient beings. For the expert meditator this practice is a form of OM since the mind is sufficiently stable to remain in the state of unconditional compassion.

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[146] Lippelt, D.P., Hommel,B. and Colzato, L.S., (2014). Focused attention, open monitoring and loving kindness meditation: Effects on attention, conflict monitoring, and creativity – A review. *Frontiers in Psychology.* Accessed on-line 25 January 2017. doi: 10.3389/fpsyg.2014.01083;
Lutz, A., Slagter, H.A., Dunne, J.D., and Davidson, R.J. (2008). Attention regulation and monitoring in meditation. *Trends Cogn. Sci.* 12 (4). 163–169. doi: 10.1016;
Vago, D.R., and Silbersweig, D.A. (2012). Self-awareness, Self-regulation, and Self-transcendence (S-ART).: A framework for understanding the neurobiological mechanisms of mindfulness. *Front. Hum. Neurosci.* 6.296. doi: 10.3389.
[147] Lutz A., Slagter H. A., Dunne J. D., and Davidson R. J. (2008). 163-169; 164.

Since training and refinement of attentional skills are common to virtually all forms of meditation, I will briefly discuss the neurophysiology of this process. As will be shown, neural dynamics are here involved. Thus, the tools of DST are analytically appropriate.

Attention is commonly conceived as composed of three functions: the modulation of arousal, alertness and engagement; stimulus selection or orienting; and attentional control processes. Three different but interrelated attentional networks control these functions. Right frontal and parietal cortex and thalamus are involved in alerting functions. Superior parietal cortex, temporal parietal junction, frontal eye fields and superior colliculus are involved in orienting. And anterior cingulate cortex, lateral ventral cortex, prefrontal cortex, basal ganglia contribute to executive control processes. Within the control network is a salience network that detects relevant events across cognitive, or emotional events in accordance with one's intentions. Finally, when attention involuntarily drifts from the target object during meditation the default mode network is engaged. It is composed of posterior cingulate cortex, medial pre-frontal cortex, posterior lateral parietal and temporal cortices and parahippocampal gyrus.[148]

It is philosophically germane that the brain areas that underlie attention can be recruited by such higher level functions such as attention, aspiration, intention and sustained effort. Once again, this suggests that downward causation is operational. Also, it is significant that the skill of enhanced attention may be described at two different scales; on the one hand as correlated with neurological function and on the other hand, as described by cognitive function. Dynamic Systems Theory is well equipped to integrate multiple scales of description.

Research into the neurological changes that correlate with meditation practice is in its infancy. Because some recent research has been conducted with experienced Buddhist meditators who were monks, factors extrinsic to meditation could not be controlled for. Thus, the impact of prayer, study and other practices may have played an unrecognized role in some of the neurological changes observed. Long-term longitudinal studies controlling for extrinsic factors (to the extent possible) are needed. With that caveat, I describe two

[148] Malinowski, P. (2013). Neural mechanisms of attentional control in mindfulness meditation. *Frontiers in Neuroscience.* 2013 Feb 4;7:8. doi: 10.3389/fnins.2013.00008. Accessed 23 January 2017.

studies that suggest long-term meditators may affect functional and structural neuroplastic modification.

Long-term meditators such as those who have accumulated 10,000 hours of meditation or more have been able to demonstrate unusually stable attention and this skill has been correlated with unusual neurological patterns such as high amplitude gamma synchrony.[149]

Lutz et al. conducted a study with eight experienced Buddhist monk meditators and a control group of 10 volunteers. The monks were estimated to have practiced meditation ranging from 10,000 to 50,000 hours. The control subjects had no previous meditation experience. During their training, the controls were asked to think of someone they care about and to let their minds be filled with a feeling of love or compassion (by imagining a sad situation and wishing freedom from suffering and well-being for those involved). EEG measurements of both groups were taken at baseline, during meditation and post meditation. During the EEG data collection period, both controls and long-term practitioners tried to generate a universal state of lovingkindness and compassion in which no one in particular was imagined. Baseline states of gamma band activity was higher in monks than in control. Gamma activity is thought to be associated with attention and affective processes. During meditation both groups increased gamma activity from baseline but the gamma band activity for the monks became highly synchronized, was distributed over long distances and the gamma waves displayed high amplitude. Long-range synchrony is thought to correlate with large populations of neurons coordinating over long distances. High amplitude is thought to correlate with the size of the neural population oscillating. The researchers claimed that, to their knowledge, the amplitude displayed by some of the monks was the highest recorded in the literature in nonpathological states. Hours of meditative practice significantly predicted the relative gamma activity during the initial baseline period as well as meditation practice. The research concluded that:

> "Our study is consistent with the idea that attention and affective processes, which gamma-band EEG synchronization may reflect, are flexible skills that can be trained. It remains for future studies to show that these EEG signatures are caused by long-term training itself and not by individual differences before the training, although

[149]Lutz,A., Greischar, L.L., Rawlings, N. B., Ricard, M., Davidson R.J. (2004). Long-term meditators Self-induce high-amplitude gamma synchrony during mental practice. *PNAS* 101(46). 16369-16373. http://www.pnas.org/content/101/46/16369.full.pdf.

> the positive correlation that we found with hours of training and other randomized controlled trials suggest that these are training-related effects".[150]

Structural changes have also been found in long-term meditators as compared with a control group. Sara Lazar conducted research in which magnetic resonance imaging (MRI) was used to assess cortical thickness in 20 long-term mindfulness meditators (non-monks) and 15 nonmeditator controls. Cortical thickness is thought to decrease with age and increase in those parts of the cerebral cortex utilized.

> "Previous studies of cortical plasticity in animals and humans have shown that when a task requires that attention be consistently directed towards a behaviourally relevant sensory stimulus (e.g. a somatosensory or auditory stimulus) over repeated practice sessions, robust changes in sensory cortical maps result".[151]

It was found that cortical thickness was increased for the meditators as compared with controls in specific areas of the brain associated with attention, interoceptive, auditory, visual, and somatosensory processing. One surprising finding was that differences in prefrontal cortex thickness was most pronounced in older participants. This result suggests that meditation might offset age-related cortical thinning in one area related to executive function (planning, decision-making etc). Finally, years of practice and change in respiration rate (a physiological measure of cumulative meditation experience) were correlated with cortical thickness in two brain regions (occipitotemporal visual cortex and right anterior insula-interceptive awareness).

These two research studies provide evidence that meditation, a specific form of top-down activity, has functional and structural neuroplastic affects in neural regions associated with the specific type of meditation practiced. In both studies, a correlation was found between length of practice and extent of neuroplastic modification. In other words, length of practice is a significant attractor. Since meditation practice is a process extended over time that typically involves several neural functions at different scales of structure and function, dynamic systems theory is an excellent method to model this dynamic process.

[150] Ibid. 16373.
[151] Ibid.

As with constraint- induced movement therapy, meditation demonstrates that the brain is plastic, exhibits hierarchical bi-directional causality and that attention, intention and sustained effort can create structural and functional neurological change. Also, since several cognitive functions (i.e. several neural networks) are acting in a co-ordinated and interdependent manner to bring about neuroplastic change in both meditation and CIMT, dynamic systems theory is an excellent method to model the multiple components of the complex systems in both activities. Finally, in both activities, neuroplasticity is occurring in accordance with the brain's own self-organisation.

3.7. Concluding Remarks

In this chapter, I have demonstrated that recent scientific research in epigenetics and neuroplasticity provides substantial evidence of the interdependence of epigenetic and neural function in response to environmental context and experience. Therefore, the brain-body-world schema is the proper conceptual framework to understand the dynamic, functional processes of genome-brain-world interaction, as posited by enactivism. And the tools of dynamic systems theory are well suited to analyse how the genome and brain are impacted by context and experience.

In the next chapter, I will discuss interpersonal and social relations and will argue that these relations are critical to the establishment and maintenance of mind.
I will show that at this scale too the brain-body-world schema is the proper conceptual framework to understand the dynamic, functional processes of -brain body-world interaction, as posited by enactivism. And the tools of dynamic systems theory are well suited to analyse how the brain are impacted by social context and experience.

Chapter 4

Interpersonal Relations as Critical in the Establishment and Maintenance of Mind

4.0. Introduction

In chapter 2, I discussed the single live cell, an example of an autopoietic system in which an organism recursively interacts with its environment. In chapter 3, the epigenome and nervous system were discussed as examples of interdependent, self-organizing, complex systems operating interactively within an environmental context. This chapter builds on the previous two chapters in that it considers the interdependence, across scales, of social relationship (chiefly, caregiver-infant attachment relationship and infant response to social stress), the epigenome and mind/brain in the establishment and maintenance of mind. It outwardly expands the complex interactions establishing mind at the scale of interpersonal relationship. In the previous two chapters, I demonstrated the value of analysing each level utilizing dynamic systems theory. Likewise, the interdependence of social relationship, the epigenome and mind/brain are analysed and explained using the tools of dynamic systems theory and enactivism. Recall that in section 3.5, I discussed research with agouti rats which suggested the possibility of applying the analysis of DST and enactivism to social relationship and the epigenome.

As shown previously, both the epigenome and brain respond to environmental stimuli moment to moment. According to the enactive perspective, they are three interdependent components of an irreducible cognitive system. We have seen that the brain is most plastic in the very young child (before age 4). Early childhood experience, even in utero, affects the development of the brain most strongly but plasticity is a neural feature throughout life. Significant emphasis in this chapter is given to the relationship between infant and primary caregiver in the process of attachment since generally, this relationship significantly shapes the mental development of the child. I also discuss the impact of trauma on neural and somatic development in which we see mind, even in the earliest stages of development, constituted by the interaction of epigenetics, neural plasticity and interpersonal relationship.

Meaning arises contextually within the life experience of the child. From the enactive perspective, "the nervous system does not process information in the computationalist sense, but creates meaning."[152] This becomes clear in caregiver-infant interaction (section4.2) in which the nature of that relationship both structures the nervous system of the infant and impacts the infant's sense of Self.

For the purposes of this chapter, I will focus on the work of Daniel Siegal and others who work within the framework of Interpersonal Neuro-Biology (IPNB).

4.1. Interpersonal Neuro-Biology: Mindsight

The IPNB framework was devised by Siegel and he named it 'Mindsight'. He says that IPNB synthesizes the research of 'over a dozen' disciplines of science.[153]

To give a brief preview of Siegal's understanding of the relationship between brain and environment, he says:

> "In my own field of psychiatry, the tremendous expansion of neuroscientific research seems to have been interpreted in the extreme by some as a call for 'biological determinism' – that is, to a view of psychiatric disorders as a result of biochemical processes, most of which are genetically determined and little influenced by experience. This impression may sound reductionistic… What is ironic, and what up until now has not been well known, is that recent findings of neural science in fact point to just the opposite: Interactions with the environment, especially relationships with other people, directly shape the development of the brain's structure and function".[154]

When the genome was first sequenced in 2000, it was commonly believed that substantial progress in resolving genetically-based disease could be made. This premature

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[152] Thompson, E. (2007). 13

[153] Siegal, D. (2012). *The developing mind: How relationships and the brain interact to shape who we are.* New York: Guilford Press. xi. Siegal does not specifically name the many scientific disciplines to which he refers. However, he does give an example of how a conciliant definition of mind was arrived at. He says that he offered a definition as a starting point to over forty scientists to find a common way of describing mind. Ibid. 2-3.

[154] Ibid. xv.

optimism was based on a belief in a reductionistic model of the function of genes. Since then, advances in molecular neurobiology have demonstrated the complexity of genomic function, including the fact that the genome creates or represses the creation of protein adaptively in response to experience (See section 3.3.). The new subdiscipline of epigenetics has demonstrated some of the mechanisms of genome-environmental interaction. Interpersonal relationships are a significant component of the context within which the structure and function of the brain and body are established and maintained.

4.1.1. What is Mindsight?

Siegal describes mindsight as:

> "a kind of focused attention that allows us to see the internal workings of our own minds. It helps us to be aware of our mental processes without being swept away by them, enables us to get ourselves off the autopilot of ingrained behaviours and habitual responses and moves us beyond the reactive emotional loops we all have a tendency to get trapped in. It allows us to "name and tame" the emotions we are experiencing, rather than being overwhelmed by them… [M]indsight allows us to examine closely, in detail and in depth, the processes by which we think, feel, and behave. And it allows us to reshape and redirect our inner experiences so that we have more freedom of choice in our everyday actions, more power to create the future, to become the author of our own story. Another way to put it is that mindsight is the basic skill that underlies everything we mean when we speak of having social and emotional intelligence"[155]

This description of Mindsight is only personal and self-reflective. However, becoming aware of one's impulsive, emotional reactions and acting appropriately, rather than reflexively, is an important social skill. This description is very similar to the practice of open monitoring meditation (OM) as I have previously described it.

To re-iterate:

> "Open-monitoring meditation directs attention to cognition itself, that is, awareness of whatever mental content arises moment to moment. No attempt is made to

[155] Siegel, D. (2010*). Mindsight: Transform your brain with the new science of kindness.* London: One World Publications. xi-xii.

supress content. Rather, the meditator is directed to observe it indifferently and nonjudgmentally. Importantly, one is required to hone the ability to 'stand aside' from mental content, not identify with it or lose the perspective of the 'indifferent observer'. When one's attention drifts or one realizes that one is no longer nonjudgmentally observing mental content (i.e. metacognition is no longer operative) one returns to non-judgemental observation."[156]

The similarity is no accident. Siegel believes that the focused, non-judgmental introspection employed in OM meditation is an important tool in the development of empathy, in positively enhancing the relational function of mind and is therapeutically useful. Thus, he has adopted it for IPNB. Mindsight incorporates two vital aspects of OM meditation: metacognition and the non-judgmental stance. Metacognition allows one reflexively to observe the process of thought. The non-judgmental stance is a necessary component of metacognition and is not separate from it. "Non-judgmental curiosity" allows one to avoid suppression of unpleasant thoughts and emotions. Both OM meditation and Mindsight seek to enhance one's familiarity, with and accept of, the presence of the contents of one's mind-- a prerequisite to cognitive change.

One of the goals of IPNB is to create a scientific and clinical understanding of the interconnections amongst brain, mind, and interpersonal relationships. The framework has three grounding principles

> "1. A core aspect of the human mind is an embodied and relational process that regulates the flow of energy and information within the brain and between brains.
> "2. The mind as an emergent property of the body and relationships is created by internal neurophysiological processes and relational experiences. In other words, the mind is a process that emerges from the distributed nervous system extending throughout the entire body, and also the communication patterns that occur within relationships.[157]

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[156] See Lippelt, Dominique P., Hommel, B., and Colzato, L. (2014). Focused attention, open monitoring and loving kindness meditation: effects on attention, conflict monitoring, and creativity – A review. *Frontiers in Psychology.* Accessed on-line 25 January 2017 doi: 10.3389/fpsyg.2014.01083
Lutz, A., Slagter, H. A., Dunne, J. D., and Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends Cognitive Science* 12(4). 163–169. doi: 10.1016.
Vago, D. R., and Silbersweig, D. A. (2012). Self-awareness, Self-regulation, and Self-transcendence (S-ART).: A framework for understanding the neurobiological mechanisms of mindfulness. *Frontiers in Human Neuroscience* 6:296. doi: 10.3389.
[157] Siegal uses the term 'emergent property' in accordance with strong dynamic systems usage. He says emergent process or property is an "ongoing process arising from the interactions of a complex system's basic parts. Emergence is a property of certain systems that make the whole greater than the sum of its parts". Siegal (2012a). A127.

> "3. The structure and function of the developing brain are determined by how the experiences, especially the interpersonal relationships, shape the genetically programmed maturation of the nervous system."[158]

Principle one is the closest Siegal comes to defining mind. He referred to this as a conciliant definition because it was the product of interdisciplinary collaboration. These three principles share much in common with the autopoietic framework put forward by Maturana and Varela and elaborated as enactivism by Varela, Thompson and Rosch and also with the epigenetic and neuroplastic material discussed in chapter 3. For example:

1. Mind is conceived as an embodied dynamic process that necessarily extends beyond skin and skull. While Siegel acknowledges elsewhere that mind is shaped by environment beyond interpersonal relationships, the focus of his interest is limited to interpersonal relationships.
2. Mind is not synonymous with brain function alone but brain function in relation to embodiment and contextual experience, specifically interpersonal relationships.
3. It is implicit that the flow of energy and information in and between brains is a circular, co-specified process.
4. Siegel's understanding of information is that it "consists of swirls of energy that have symbolic content".[159] Symbolic meaning is embedded in a set of sounds if the symbolic meaning references a larger context with which one is familiar. For example, a Greek word has no symbolic meaning to one who has no familiarity with the language. Energy flow refers to the ways in which energy (as the term is used in physics) is transferred and translated. It has informational value when patterns of neural firing match with prior learning. Thus, as with enactivism, information is context dependent.
5. Mind is an emergent property constituted by brain, body and contextual experience, specifically interpersonal relationships and instantiated neurophysiologically. Siegel emphasises communication patterns as a significant environmental factor, perhaps because of his focus on interpersonal relationship. Maturana and Varela also highlighted communication as an emergent property in their book *The Tree of Knowledge.*

[158] Siegel (2012). 3.
[159] Ibid. 6.

6. According to Siegel, the structure and function of the developing brain is determined by how experiences, especially interpersonal relationships, shape the genetically programmed maturation of the nervous system. One could interpret this statement as meaning that he considers this process as uni-directional (experience activating or suppressing epigenomic function) rather than bidirectional and recursive. However, later we shall show that, like Varela et al, he considers the process to be bi-directional and recursive.
7. Although not specifically stated here, implicit in these three foundational principles is that mind/brain is conceived as a complex, dynamical system. This is made explicit below.

The point is that the framework of IPNB and that of Maturana, Varela, and Thompson share enough in common that IPNB may be used in this dissertation to extend the autopoietic/enactivist framework beyond 'lower level' biology to encompass its interdependence with social relationship. However, it is important to note that Siegal uses some language and concepts predominant in mainstream cognitive science, specifically related to the model of the brain as a computer.[160] In describing his views, I may use his language, but I shall clarify as necessary.

Before moving on, I want to flesh out some of the key elements of IPNB.

4.1.2. The Brain as System and Subsystem[161]

As a living system, the brain is thermodynamically open and dynamic. As such, it is continually modulating its activity in response to the environment in which it is embedded. It is composed of differentiated subsystems that are linked into an integrated, functional unit and results in systemic behaviour not functionally reducible to its individual components. The subsystems are arranged hierarchically and, when integrated, operate well, but when not well integrated create chaos (in systems terms) or psychopathology (in psychological terms). In other words, the brain is a complex, Self-organizing, dynamic

[160] Siegel uses the analogy of the computer as an information processing system to process data, including representations, whereas Varela and Thompson deny that this analogy adequately describes the recursive and bidirectional flow of energy and information between brain, body, and environment. They also contest the role usually attributed to representations by those who consider cognition as data processing. In this chapter, I will not weigh in on this dispute.

[161] See Haugeland, J. (1998). Mind embodied and embedded in Haugeland, J. (Ed.).(1998). *Having thought: Essays in the metaphysics of mind.* Cambridge, Mass: Harvard U.P. 207-237.

system with properties which emerge in interaction with several neural subsystems. But it is also a subsystem of a larger complex dynamic system, which includes the body (with all its subsystems) and social relationships. As with the brain, this larger system operates bi-directionally and recursively.

According to Siegal, one way to understand psychopathology is that failure of Self-regulation, that is, failure to well integrate components of energy and information flow, may result in poor Self-organization which may manifest as disease or dysfunction. And conversely, well-integrated self-organization may then result in peak self-regulation and integration. He believes that this analysis may apply not only to psychopathological dysfunction but to all dysfunction and disease. Siegal says:

> "Does the self-organizing emergent property that derives from complexity theory overlap with 'self-regulation', a primary focus in the field of psychopathology? If so, this may be a conceptual bridge linking two independent fields. One implication of this possible overlap is that 'impairments to self-regulation' suggested by the field of developmental psychopathology as central to mental dysfunction may be fundamentally 'impairments to self-organization'. And if self-organization moves the system to the most flexible, adaptive, and harmonious states with integration, then perhaps self-regulation too, is dependent on integration. And now we can state the notion that dysregulation comes from non-integrated functioning. Given that integration produces harmonious and flexible functioning and that impairments to integration yield chaos, rigidity, or both, we can predict that dysregulation will result in this pattern of dysfunction".[162]

For example, Siegal hypothesizes that the "DSM-IV-TR's entire list of psychiatric disorders can be reframed within this perspective as revealing chaos and/or rigidity, and so as reflecting impaired integration".[163] He claims that:

> "Recent studies in trauma and in neural functioning in the non-task-performing default or 'resting state' support the proposal that impaired integration is the common mechanism among disorders or health, whether they have primarily experiential or non-experiential (e.g., genetic, toxic, infectious or random) origins".[164]

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[162] Siegel (2012). 28-29.
[163] Ibid. 29.
[164] Ibid.

Granted, Siegal's hypothesis equating all psychiatric illness with failure of self-regulation leading to impairments in integration may be radical and speculative. Siegal's hypothesis may be tested empirically by correlating neurophysiological disorganization with dysfunction and conversely, coordinated self-organization with proper function. However, this does not resolve the "chicken and egg question" of whether disorganization causes dysfunction or dysfunction causes disorganization. From the dynamic systems perspective, the "chicken and egg question" would seem straightforward. If we represent both dysfunction and disorganisation as attractor basins within phase space, then we can pose the question about precedence by seeing how their relative depths change over time. At time T1, which has the deeper basin of attraction? At time T2, how have the depths of the two basins of attraction evolved? If both disorganisation and dysfunction are deteriorating then both basins are becoming deeper. In observing the changes over time we are looking to determine whether the change in one precedes the change in the other or whether one changes at a faster rate than the other.

In the theoretic framework of both Siegal and Maturana, Varela and Thompson, self-organization is a lynchpin concept linking life in its most fundamental to most complex forms, both in wellness and dysfunction. This is a process-oriented view which is not embraced by the majority of theoreticians at this time, but it is a position that I adopt, as I am interested in viewing mind as an emergent feature arising from the interaction of brain, body and world. As I have previously stated, there is scope for both the systems process view of life and the reductionistic view, depending on the purpose for which methodology is to be employed. As such, these two methodologies are complementary.

In this chapter, I will investigate the impact of social relationships on the self-organization of the brain via dynamic systems theory, specifically focusing on attachment theory, emotion, memory, and the impact of chronic social and interpersonal trauma, a form of severe chronic stress. Although discussed separately, each of these are interlinked through the limbic system. These topics will be dealt with in brief since a more detailed review is beyond the scope of this dissertation. But before discussing these, it is useful to consider Siegal's analysis of neural development and modification as this bears on complexity of self-organization.

Siegal describes neurologically functional levels hierarchically, showing how they operate interdependently at increasing levels of complexity. As we will see, this hierarchical description accords well with dynamic systems theory.

He uses the term *states of mind* to describe "the total pattern of neural activations in the brain at a particular point in time".[165] These complex patterns of integrated features allow the brain to achieve cohesion in functioning.[166] Patterns of neural activation within regions of the brain are referred to as *neural net profiles*. These describe the activation of specific neural circuits which mediate information processing. Neural net profiles in turn are distributed and interconnected with a large range of other neural net profiles which aggregate to create complex inputs and outputs to facilitate various functions. Siegal gives the example of a fearful state of mind. At a basic level, he says, this state is constituted by a cluster of related functionally synergetic processes such as heightened caution, focal attention, behavioural hypervigilance, memories of past experiences of threat, models of the self as a victim, emotional arousal in preparation of mind and body in response.[167] Cohesion amongst these processes serves the purpose of creating maximum efficiency, both in terms of information and physical preparedness, to contend with whatever is presented. The processes described above may be broken down into functional components as described below.

Mental representations are constituted by patterns of activation of neural circuits. A mental representation is an active, dynamic process linking brain, body and world that leads or may lead to further neural activations. This conceptualization is in line with the Varela and Thompson's enactivist view that a self-organized system with operational closure (an autopoietic system) does not represent an independent world but rather enacts a world inseparable from its embodied structure. One could interpret the nature of this interdependence as nonmodular. This may be contrasted with the classical cognitivist view of mental representation in which the brain and its structures are modular. According to

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[165] Ibid. 186. One might think that Siegal conflates mind and brain, but I would argue that this is not so. He believes that mind arises from brain function, but that mind is an emergent process and as such, cannot be reduced.

[166] Cohesiveness is a qualitative term used to describe the synchrony that occurs during integration. Varela et al. have described cohesion as long-range synchrony of gamma waves. Varela. F., Lachaux, J.-P., Rodriguez, E. and Martinerie, J. (April,2001). The Brainweb: Phase synchronization and large-scale integration. *Nature Review Neuroscience* 2(4). 229-239.

[167] Ibid.

this view, mental representations are more like memory storage and retrieval and unlike dynamic reconstruction.

Mental representations differ (amongst themselves) in the patterns of neural activation and locations of neural circuits activated. 'Simple' representations may 'scale up' to create more complex mental representations. For example, sensory representations may be created by neural circuits which are activated by stimuli outside the body. These representations may be processed and transformed into more complex representations by the transmission of the simple representation to a hierarchically higher brain structure such as the neocortex where a concept may be attached to the representation. Localization of neural processing creates the specificity of the experience of mental representations shaping the content of information and its subjective quality.[168]

A set of neural circuits carrying a certain type of information and utilizing a similar form of neural signal is referred to by Siegal as a *module.* For example, the module for processing visual input involves signals sent from the eyes to the occipital cortex. This module may include circuits that detect shapes, contrasts, or angles. Similar modules process information to compose a *mode*. For example, the visual input module together with other visual modules process information into more complex representations referred to as visual modes. Modes may in turn be processed together to form a *system*. Following this example, the visual mode may be combined with other perceptual modes to create the perceptual system. Systems in turn are bound together to create *processes***.**[169] The *state of mind* clusters the activity of system processes which are only then subjectively experienced. The activities of the brain are organized in patterns of layers which become increasingly complex.

This hierarchical description, based on the assumption of the brain as composed of discrete, interacting systems, is problematic. One challenge faced by such a description of hierarchical and serial processing is how the world is perceptually experienced as unified when the processes above each take a certain amount of time. We need not concern ourselves with this problem, for now what we are concerned with are 'states of mind'. A state of mind both coordinates complex neural activity moment to moment and creates a

[168] Siegal (2012). 186-187.
[169] Ibid. 188-189.

pattern of neural activation that can become engrained and therefore more likely to recur both as a remembered experience and as a neural net profile. In other words, a state of mind emerges from the increasing complexity of scales and acts downwardly to constrain the activity of lower scales. If downward action occurs, then at the level of the neuron, synapses are configured or reconfigured to strengthen or modify the neural net profile. This is referred to as synaptic plasticity. Siegal proposes that a state of mind may be composed of functionally interlinked, multiscale systems such as perceptual bias, emotional tone and regulation, memory processes, mental models, and behavioural response patterns.[170] If a traumatic experience occurs to which the mind cannot adequately adapt, it cannot effectively Self-organize in response. Dysfunctional states of mind contain one or more dysfunctional elements. Consider, for example, PTSD. In severe cases, several of the above-mentioned systems may be affected. One might experience flashbacks, emotional turmoil and dysfunctional behavioural patterns. These effects may be conceived as the result of circular, recursive causality.

Significantly for therapeutic purposes, Siegal claims that one can become aware of the effect of individual elements (perceptions, feelings, thoughts, memories, attitudes, beliefs and desires) that compose one's state of mind. Presumably then, one may be able to judge the functionality or dysfunctionality of each, which then enables one to evaluate how these may influence behaviour and interpersonal relationships, a process of downward causation.[171] One might then begin to resolve dysfunctional elements.

From a systems perspective, such judgments involve higher cognitive functions and may be conceived as a phase transition, a transition from one state of mind to another. Since multiple modules, modes, systems and processes are interlinked and interdependent, it is conceivable that each may at least potentially be a control parameter and the change of one or more might lead to dynamic instability and to a phase transition.

Let us take a concrete example to show how this might work within the framework of the dynamic systems model. Let us suppose a young boy is repeatedly abused, beaten by a parent for years without apparent reason. The beatings effect neural changes at multiple scales which instantiate pain, fear, lack of trust of others and a variety of beliefs such as the

[170] Ibid. 189.
[171] Ibid. 190.

cruelty of people generally and specifically those most intimate, lack of safety in interpersonal and social relationship etc. As the child grows up perceptions, experiences and judgments of others are negatively biased; memories, thoughts, and experience rationalize, justify, and support these biases. His attitudes and desires become consistent with the belief in an unsafe, dangerous world. Individually and collectively these memories, thoughts and judgements may become deep basins of attraction. He may experience a generalized dysfunctional feeling tone, a state of mind that pervades his life. This state of mind (in Siegal's sense) may be characterised as a phase profile. He may even forget how these biased elements were first instantiated. "It's just the way it is", he believes.

Let us assume this person eventually becomes involved in a relationship with someone who cares deeply about him and she consistently treats him well. Nevertheless, because of the phase profile due to all these influences (composed of deep basins of attraction of several negative beliefs, attitudes, judgments etc which in turn are instantiated at multiple neural scales), he fails to trust her. Then let us suppose she says the following: "I've only treated you lovingly and you treat me like the enemy". The statement could potentially cause dynamic instability leading to a bifurcation in which he either challenges his beliefs and defence mechanisms or reinforces them. Both possibilities exist in metastability (either as tendencies or states of mind). If he defends against the truth of the statement, dynamic instability may not be created, and a bifurcation may not occur. He remains defensive and dynamically stable. However, if he takes the statement to heart, a dynamic instability leading to bifurcation and phase transition may occur as described below.

Let us suppose that the latter occurs. For some reason, he considers the statement and realizes it may be true. For the sake of this example, let us suppose that conscious and unconscious beliefs generally are control parameters and specifically (for simplicity in this example) that the unconscious belief in the danger of intimate relationship is the strongest control parameter. Before this comment the basin of attraction of this belief was very deep and it maintains the negative stability (deep basin of attraction) of all the other factors- biased perceptions, negative feelings, thoughts, memories, attitudes, beliefs and desires. Then the man begins to examine the inconsistency between the way his partner treats him and the way he fears being treated by her. In shifting to his evaluative faculty, he has engaged a phase transition (from 'lower level' to 'higher level' neuronal activation and cognitive function). He decides to engage in therapy. In the therapeutic process he becomes aware of his unconscious negative beliefs, fears, attitudes, judgments etc and realizes the extent to which these have influenced every aspect of his life and the extent to which they are inconsistent with his current relationship. These realizations and his continuing analysis begin to affect his beliefs, attitudes, etc. in a dynamic way which then affects the biases constituting his state of mind. The basin of attraction of the belief control parameter has become shallower.

Let us hypothesize another potential point of dynamic instability; his girlfriend threatens to leave the relationship because he is emotionally unavailable. This may cause another bifurcation. If he realizes he loves her and may lose her, that realization may precipitate dynamic instability which, in turn, may lead to a bifurcation and phase transition in which he realizes that his entire way of being in the world is conditioned by circumstances no longer applicable in his life. He may then begin the long process of unravelling the perceptual biases, etc. He catches inappropriate negative attitudes and thoughts and begins to make them appropriate to the situation at hand. Gradually the feeling tone of his life begins to change as the basins of attraction corresponding to the previously held negative beliefs, attitudes, etc become shallower. And trait changes may be neurologically instantiated by the creation of neural circuits less dysfunctional and the gradual disconnection of neural circuits creating fear, etc.

The systems perspective used in this example is compatible with Siegal's functional description above. From the therapeutic perspective, one benefit of the systems model is the ability of an individual, in principle, to become aware of their dysfunctional control parameters and to examine and evaluate the strength of these in the establishment of dysfunction. This could facilitate a process which allows one to affect beneficial change in dysfunctional states of mind, an example of bi-directional causation. If it is true that awareness can facilitate change, then awareness of one's emotional and cognitive states is a significant control parameter. Mindsight is premised on the truth of this hypothesis.

Siegal proposes that emotion, rather than being just another module, serves also the vital function of coordinating the activity of specific systems of processing. The regulation of emotion is mediated in part by the limbic and prefrontal regions of the brain which function to coordinate a wide range of neural activity.[172] So higher level (conscious) cognitive

[172] Ibid. 188-189.

regulation (metacognition) may also be a control parameter as it can mediate emotion. Ideally these are developed early in life.

Moving on from the hypothetical example and on the developmental side, the ability of the infant to develop the capacity to modulate emotion effectively is critical to healthy mental function. Modulation of emotion refers to the reduction in the intensity of an emotional experience and/or the length of time one experiences a dominant emotion. To regulate her own emotional states, the infant initially wholly relies on the emotional regulation of the primary caregiver. In this regard interpersonal relationship is formative. Infant-caregiver attachment is the critical phase in which the infant first develops emotional regulation and does so as a direct consequence of their first interpersonal relationship. And failure of the infant to effectively develop this capacity during this time puts her at increased risk of psychopathology in the future. The attachment process may be analysed using the tools of dynamic systems theory as discussed below.

Even beyond the phase of attachment, social relationships constitute a significant element of experience that can induce wide-ranging epigenetic and neuronal change because relational neural networks are tightly linked to a range of other networks.

> "Relationship experiences have a dominant influence on the brain because the circuits responsible for social perception are the same as or tightly linked to those that integrate the important functions controlling the creation of meaning, the regulation of bodily states, the modulation of emotion, the organization of memory, and the capacity for interpersonal communication."[173]

Because these networks operate recursively, and in many cases bi-directionally, relational experience can have wide-ranging cognitive effects leading ultimately to extensive increased (or decreased) Self-organization and integration or (dis-integration). Attachment between caregiver and infant is one significant aspect of interpersonal relationship on which I will concentrate for the purposes of this chapter.

[173] Ibid. 33.

4.2. Caregiver-Infant Attachment Theory

The phenomenon of caregiver-infant attachment provides an excellent example of interpersonal relationship best conceived as a dynamic system operating at several scales of complexity. This section discusses traditional attachment theory, highlighting its explanatory inadequacy in that it provides weak or inconsistent correlations between caregiver and infant attachment styles. I suggest that the traditional theory fails because it does not account for a diverse array of factors which also may influence infant-caregiver attachment. This diverse array is better captured by dynamic systems approaches. The purpose of this section is to demonstrate that this very important aspect of interpersonal relationship is best conceptualized as a dynamic system whose neural Self-organization may constitute either an impediment or stepping-stone to integration and well-being. In principle, if more factors, such as genetic and epigenetic influence and contextual experiences where considered interdependently with caregiver attachment style, a stronger predictive model would result. Unfortunately, due to a paucity of research in this area to date, this hypothesis remains theoretical. Perhaps for this reason, Siegal uses the attachment classification system originated by Ainsworth, which is not dynamically based, even though she claims to advocate a systems approach to the understanding of the development of mind.

Attachment theory, as developed by Ainsworth and Bowlby, proposed that secure attachment results from the sensitive and appropriate responses of the primary caregiver (typically but not exclusively conceived as the mother) to the needs and signals of the infant.[174] Ainsworth conceived the notion of attachment as providing a secure base for the infant under these circumstances. Her conclusion was based on data gathered in research termed the Baltimore study. The study highlighted the quality of the caregiver-infant relationship, specifically, sensitivity of the mother to the signals of the infant. However, the study gave insufficient attention to other factors likely to impact caregiver-infant

[174] Ainsworth, M., et al. (1962). *Deprivation of maternal care: A reassessment of its effects*. Geneva: World Health Organization.
Bowlby J. (1969/1997). *Attachment and loss: Attachment Vol. 1* London: Pimlico (Random House).
Bowlby J. (1988). *A secure base: Clinical applications of attachment theory.* London: Routledge.
Bretherton, I. (1992). The origins of attachment theory: John Bowlby and Mary Ainsworth *Developmental Psychology* 28. 759-77. Accessed 1 March 2017.
http://www.psychology.sunysb.edu/attachment/online/inge_origins.pdf.

attachment such other interpersonal relationships, epigenetic influences (such as contextual environment) and the personality of the infant. Attempts to specify the origins of attachment behaviour have been constrained by the limitations of traditional development theory. Dynamic systems theory has begun to be employed to investigate the complex array of individual and environmental factors that together interact in complex and nonlinear ways to produce attachment behaviour.

> "By viewing attachment as a complex, open system, composed of numerous subsystems of component processes, with biological, social, cognitive, and behavioural bases operating both independently and in mutually dependent ways instead of focusing exclusively on specific parent and infant behaviours, our understanding of the development and expression of attachment behaviour is likely to be greatly enhanced".[175]

The systems approach is consistent with John Bowlby's original theory of attachment in which he stated that attachment is not reducible to specific behaviours but rather exists as a complex socioemotional system consisting of several subsystems operating interactively to assure survival. Bowlby identified five infant behaviours that signal the need for mother-infant interaction: crying, smiling, sucking, clinging, and following. He also suggested that the central nervous systems of mother and infant operated hierarchically, with mother's executive functions controlling an elaborate network of bidirectional communication capabilities of the subsystems, in which the infant is an active participant.[176]

Bowlby and Ainsworth believed that attachment developed gradually and could be delineated in four phases. Phase one, *pre-attachment* extends from birth to 8-12 weeks during which the infant directs vision and reaches out to others indiscriminately. Contact-promoting behaviours include crying, babbling, and smiling. Phase two, *attachment-in-the-making* extends to 7 months. Here the infant distinguishes the primary caregiver from others and reaches out actively toward her to promote contact. Phase three extends to the second or third year of life and is identified as the phase of *clear-cut attachments*. Crawling and walking facilitate the infant's ability to seek closeness with the caregiver. Phase four,

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[175] Coleman, P., and Watson, A. (2000). Infant attachment as a dynamic system. *Human Development* 43. 295-313. Accessed 27 February 2017 on Karger.com/Article/Pdf/2269.
[176] Ibid. 299.

termed *goal-directed partnership* begins at 2 to 3 years. It is characterized by the child's ability to understand the caregiver's goals, feelings and points of view.[177]
From a dynamic systems perspective, the four phases of attachment may be conceived as a phase portrait which changes through four different landscapes.

According to Bowlby and Ainsworth, in each of these phases, development of attachment is achieved by a combination of cognitive, physical, emotional and motivational capacities which are interrelated and interdependent, all of which mature as the infant matures. For example, early attachment experiences are associated with anatomical and physiological changes. The period from 7 to 15 months is critical for myelination and growth of limbic and cortical association areas. These developments are not driven by biology alone. Neurological maturation is dependent, in part, on the presence of nurturance and affection in the caregiver-infant relationship. Corticolimbic function is associated with the emergence of affect, regulatory, and cognitive functions. This period corresponds with phase three in which the child seeks proximity to the caregiver whose departure causes fear and protest. The caregiver's presence serves as a safe base from which the child may venture to explore the environment. Initially infant emotional regulation is regulated by others, but emotions become more Self-regulated as the result of the infant's neurological maturation and appropriate interaction with the caregiver. Neuroplastic effects are fostered by social interaction.

It is clear that development at all scales is a set of complex processes from birth onwards. Healthy Self-organization and Self-regulation of the infant relies on functional integration of epigenetic, neural, and social factors. This can be analysed and explained by the tools of DST.

> "The dynamic model of behavioural development essentially proposes that various components are organized for functional purposes in a fluid arrangement that is determined by the maturational status of the organism, prior experiences, and the current context with causal equivalence assigned to all system components. According to dynamic systems theory, new behavioural states emerge when systemic components are pushed beyond certain critical values or when the

[177] Ibid. 300.

> relations among the components change... Any systemic component that operates as a primary agent of change is referred to as a 'control parameter'"[178]

For example, proximity seeking grows more individual and complex as the child matures due to system-context interaction. In response to phase shifts arising from such interaction, socioemotional abilities underlying attachment behaviours become more complex, hierarchically arranged, integrated, differentiated, and automatic while becoming less flexible. Essentially, the child's attachment behaviours become Self-organized due the dynamics of systemic interaction.[179]

What is lurking but not explicitly stated in the above quotation is the role of recursive feedback loops (which I have previously referred to as recursive bi-directional co-specification) amongst the control parameters in the systemic dynamic process. For example, in the infant-mother interaction, if the mother sensitively responds to the cues given by the infant, the infant in turn responds to these and the mother is affected by the infant's responsiveness. The relationship between maternal sensitivity and quality of attachment has found empirical support in the research of several investigators but other researchers have demonstrated weak or insignificant relationships between these two factors. This data, taken together, supports the hypothesis that maternal sensitivity together with a variety of other control parameters may be at play in attachment. "In all likelihood, security of attachment is based on numerous parental, child, and situational factors interacting in a complex manner."[180] The mother's empathetic recognition of and response to the state of mind of the infant affirms the infant and aids the empathetic, neurological, cognitive, and emotional development and maturation of the infant. Conversely, the inability of the mother to empathetically respond to the cues of the infant may lead to a variety of adverse neurological and behavioural consequences. And there is some evidence that the infant, even as young as seven months, may also have the ability to recognize the mother's state of mind and respond accordingly.[181] This recent study of the infant's competence in theory of mind deserves some comment as it suggests a newly

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[178] Ibid. 302-303.
[179] Ibid. 303.
[180] Ibid. 297.
[181] University of Illinois at Urbana-Champaign. (2018, May 7). New evidence that infants track others' mental states. ***ScienceDaily***. Accessed May 8, 2018 from: www.sciencedaily.com/releases/2018/05/180507111824.htm.

discovered complex, dynamic, interactive mechanism in which both infant and mother engage, contrary to previously held views.

Theory of mind is the ability to think or otherwise grasp others' mental states, their thoughts, beliefs, emotions and any other form of cognition. In this study, Hyde et al. used near-infrared spectroscopy to track the neural activity of seven-month old male and female infants as they watched videos of actors seeing or failing to see an object moved from one location to another. From the video, infants were able to observe where the object was actually moved. The researchers observed the infants' neural activity at the temporo-parietal junction (TPJ) as they observed the video. TPJ had previously been shown to be active when this same experiment was performed with adults. Both infant and adult neural activity was more active during scenarios when the actor's belief regarding the location of the object was false compared with scenarios when her belief was true. These results suggest that the TPJ shows some functional organization relevant to high-level social cognition such as theory of mind as early as seven months of age. Furthermore, these results suggest that infants may draw on core mechanisms similar to adults to implicitly track beliefs of others. If infants do indeed grasp their caregiver's state of mind and vice versa, this may be a mechanism of neural resonance and empathy somewhat like the mirror neuron mechanism, both of which serve to draw the participants relationally closer. It seems likely that this mechanism of infants, initially primitive and arational, matures as the brain matures and the ability to reason arises.

The infant's increasingly mature and complex faculties can then be utilized to engage with the mother in more sophisticated ways. The quality of attachment has long-term consequences, because synaptic connections are created early in life that may create and reinforce particular mental functions and predispositions toward the interpretation of experience thereby influencing one's interactions with the world. For example, creation of a secure attachment base plays a role in the proper development of neurological and other subsystems which in turn may play a role, with a variety of other factors, in behaviour. For example, a secure attachment base serves as a foundation for the secure child to explore the world independently. On the other hand, insecure or negligent attachment plays a part in the underdevelopment of one or more subsystems, which in turn may also impact behaviour later in life, but not in as functional a manner.

Ainsworth distinguished three attachment styles: secure, insecure avoidant and insecure ambivalent/resistant. A fourth, 'disorganized', was later added by Mary Main and Judith Solomon. These were not considered to be exclusive but rather to designate predominant patterns of mother-child interaction. Attachment patterns are important because the child is thought to internalize a pattern as a working model. The internal working model of attachment is theorized as a mental schema utilizing 'evocative memory' by the infant from 18 months of age. In her absence, the attachment figure is thought to be evoked in memory to bring comfort to the child during separation. If attachment is healthy, the child will be able to separate and explore the world in a functionally healthy manner. But if the attachment style is not healthy and secure, then the internal working model of attachment for the child will not be secure and play, exploration and social interactions may be impaired. Presumably, the infant's attachment style is neurologically dynamic, represented globally and integrates a number of modes, as Siegal uses the term. Recall that, according to Siegal, modules, modes, systems, processes and states of mind aggregate hierarchically to create increasingly complex functions. Thus, through complex, dynamic, interdependent sets of functions at multiple scales, attachment style may (or may not, depending upon the influence of a multiplicity of other factors) result in certain infant states of mind.

In the Baltimore study, Ainsworth sought to develop a quantitative measure of assessment for the security of attachment. In the study, mother-infant interaction[182] was observed in the home during the infant's first year of life. At the end of the year, mother and child were brought into the lab. During a 20-minute period, the child was exposed to different situations with the mother, with mother and stranger together, then infant alone and finally, reunited with mother. The working hypothesis was that the child's attachment system would be activated when she was left alone and when she was in the company of the stranger. Behaviour of the child at reunion was found to fall into patterns. The mother's state of mind was determined by the Adult Attachment Interview (AAI). The infant's state of mind was categorized according to Infant Strange Situation behaviour. Where the mother was *secure/autonomous* the infant was *secure***.** Where the mother was *dismissing* the child was *avoidant***.** Where the mother was *preoccupied* the child was *resistant or ambivalent***.** And where the mother was *disorganized* (lapse in reasoning or discourse

[182] In the Baltimore study, all the caregivers were mothers.

during discussions of loss or abuse) the child was *disorganized/disoriented* (example: child freezes with trance-like expression).

Ainsworth suggested what came to be known as the 'caregiver sensitivity hypothesis' as an explanation of the attachment styles of caregiver and infant. Sensitive mothers are responsive to the infant's needs, moods and feelings. The caregiver's sensitivity, in this instance, produces a secure internal working model in the infant and mental representations of others as helpful and worthy of respect. Mothers, who are less sensitive to the signals of the infant, create less functional internal working models in the infant. For instance, a mother who is dismissing would tend to instantiate in the infant an internal working model of being unloved and rejected, unworthy and unacceptable.[183]

This classification, while predominant, is not without its critics. For example,

> "After 25 years of research and clinical application, it is becoming clear that assessments of attachment: (1) rarely do more than differentiate securely attached children and adults from insecurely attached individuals; (2) only weakly differentiate those with psychological disorder or child protection needs from those without such problems; (3) account for unexpectedly modest variance among individuals on important precursors and outcomes and (4) often put cases of risk into a single "disorganized/unresolved/ cannot classify" category, thus providing little differentiation relevant to treatment decisions. Thompson and Raikes concluded that a new conceptualization of attachment is needed and that it should reflect the input of maturation, developmental processes, context and culture, and individual change; they cited Crittenden's work repeatedly as a guide to future progress".[184]

In the same vein:

> "[E]vidence for continuity of attachment from mother to infant is more robust for secure attachment than for anxious (insecure) attachment. In a meta-analysis of 661 dyads in 13 studies, Van IJzendoorn (1995) found that 75% of mothers and infants had matching secure versus insecure classifications. However, when a four-way classification (secure, avoidant, ambivalent, and disorganized) was tested, mother–infant agreement dropped to 63% with even less agreement seen for insecure attachment groups. This suggests that the intergenerational transmission of

[183] McLeod, S. *Mary Ainsworth* https://www.simplypsychology.org/mary-ainsworth.html . Accessed 28 Oct 2019.
[184] Crittenden, P.M. (2010). Preface: Pathways forward. *Clinical Child Psychology and Psychiatry* 15(3) 299-301, 299.

> attachment may be more complex than a direct replication of the mother's pattern, and that the patterns of infant and adult attachment might be multi-dimensional.*"*[185]

The suggestion is that a conceptualization more compatible with dynamic systems theory is needed. Crittenden has developed the Dynamic-Maturational Model (DMM) of attachment and adaptation. Although DMM has spread to Europe since its inception, Crittenden has speculated that it has not been more widely adopted because of its complexity. Crittenden has described DMM as follows:

> "The Dynamic-Maturational Model of Attachment and Adaptation emphasizes the dynamic interaction of the maturation of the human organism, across the life-span, with the contexts in which maturational possibilities are used to protect the Self, reproduce, and protect one's progeny. Maturation is both neurological/mental and also physical. Maturation involves both the increase in potential during childhood and adulthood and also the ultimate decrease in potential in old age. Contexts include both the people and places that affect development, e.g., family, school. Context also includes the intra-and-interpersonal challenges of different periods of the life-span."[186]

The study of attachment may slowly be undergoing a change in theoretical framework as the recognition increasingly dawns that the complex, interdependent factors composing attachment require more sophisticated analysis and a more inclusive classification schema. This view is bolstered by research demonstrating that there may be a moderate (as opposed to strong) correlation between mother's attachment style and infant's developing personality. Attachment involves the development of several infant neural subsystems, one of which is affective.

Next I will discuss the role of emotion and memory in attachment and social relationship. If Ainsworth was correct in her hypothesis that the quality of the caregiver-infant attachment relationship creates an internal working model in the infant, then it also serves as an internal working model for either more or less expansive and functional (or dysfunctional) interpersonal and social relationships. The disruptive influence of

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[185] Shah P.E., Fonagy, P., and Strathearn, L.(2010). Is attachment transmitted across generations? The plot thickens. *Clinical Child Psychology and Psychiatry* 15(3). 329–345, 330.

[186] https://www.patcrittenden.com/include/overview.htm. Accessed 28 Oct 2019.

interpersonal and social stress on the infant or child is a significant perturbation which may mould both the child's neurophysiology and internal working model.

4.3. The Limbic System[187]: Emotion, Memory and the Impact of Interpersonal and Social Stress

As previously mentioned, Siegal believes that emotion plays a pivotal role in coordinating and integrating the functions of several neural subsystems (section 4.2.2.). If he is correct, then the limbic system, which contains structures important to emotion, memory and related functions, must be carefully tended during and after caregiver-infant attachment in order to facilitate healthy neural and psycho-social development. I will discuss two functions of the limbic system that deserve attention, namely emotion and memory, with an eye on how DST analysis can incorporate these factors too.

4.3.1. Emotion

Siegal arrived at his conception of emotion by incorporating research and clinical (rather than phenomenological) concepts from several disciplines for the purpose of clarifying the basic functions of emotion and characterizing which features are shared and which are distinct. He believes that emotion involves complex layers of processes in interaction with the environment from moment to moment. These interactions include cognitive processes such as appraisal and evaluation of meaning. They also involve physiological changes such as endocrine, autonomic and cardiovascular changes in response to the environment. He says:

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[187] The term 'limbic system' has been criticised by Joseph LeDoux as misleading. "One of the biggest surprises from LeDoux's work is that there may be no such thing as the limbic system -- a brain structure that has been supposed to underlie emotion. 'All students are taught about the limbic system, LeDoux said, 'but in my opinion, it's no longer a valid concept'. 'Anatomists like LeDoux are funny people,' said Dr. Paul MacLean, the scientist who coined the term limbic system…. 'The limbic system is still a valid concept, he said, adding that 'efforts to discard the idea were ill-founded'." *The Emotional Brain.* New York: Simon and Schuster. http://www.cns.nyu.edu/ledoux/the_emotional_brain/book_times_related.html. Accessed 3 June 2017. LeDoux, J. (1998).

For my purposes I will refer to the limbic system since it is commonly in use and the structures and functions designated by the term demonstrate integrative features.

> "[L]et's consider that emotions represent dynamic processes created within the socially influenced, value-appraising processes of the brain. Emotion reflects the essential way in which the mind emerges from the interface of neurophysiological processes and interpersonal relationships: It serves as a set of integrating processes linking various systems in a dynamic flow across domains and through time…. Within the brain itself, emotion links various systems together to form a state of mind. Emotion serves as a set of processes connecting one mind to another within interpersonal relationships…[E]motions are proposed to be changes in the state of integration."[188]

"Changes in the state of integration" refers to the changes in the interaction and integration of the differentiated neuro-physiological components which together create the emotion. Disturbing emotions may be thought of as disturbing because they cause 'dis-integration' of these components whereas positive emotions tend to enhance integration.[189] If Siegal is correct that positive emotions are integrating and negative emotions are dis-integrating, then research should demonstrate that chronic negative emotions tend to lead to ill health and conversely, positive emotions tend to lead toward good health. A raft of research in psychoneuroimmunology has demonstrated that this is in fact the case. Psychoneuroimmunology examines the interaction of four systems: the nervous system, endocrine system, immune system and mind. Adler and Cohen describe the interdependence of the systems as follows:

> "Previously unknown and unsuspected connections between the brain and the immune system provide a foundation for the now numerous observations both (a) that the manipulation of the neural and endocrine functions alters immune responses and the antigenic stimulation that induces an immune response results in changes in neural and endocrine function and (b)that behavioural processes are capable of influencing immunologic reactivity and conversely, the immune status of an organism has consequences for behaviour. This new research indicates that the nervous and immune systems, the two most complex systems involved in the maintenance of homeostasis, represent an integrated mechanism contributing to the adaptation of the individual and the species."[190]

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[188] Siegal (2012). 148.
[189] Ibid.
[190] Adler, R., and Cohen, N. (1993). Psychoneuroimmunology: Conditioning and stress. *Annual Review Psychology* 44. 53-85, 53-54.

Several observations can be made which demonstrate that these four biological systems may be conceived as a larger complex, dynamic system (which are amenable to the DST analysis and explanation). First, there is a bi-directional, recursive causal relationship operating moment to moment. This type of relationship results in emergent features such as homeostasis. Second, although the quote does not specifically mention interdependence, it is clear that the relationship of these four systems must be interdependent for homeostatic dynamic equilibrium to emerge. Third, although behaviour is linked only to immunologic activity, it is clear that this is not meant to negate the contributions of the other systems to behaviour which may also be conceived as an emergent feature. Finally, if homeostasis is an emergent feature of the four systems operating interdependently, then one or more systems may disrupt homeostasis. If chronic negative emotions disrupt one or more of the systems and are disintegrating, then immune function may not function well, and homeostasis may be disrupted. In summary, it is possible to confirm that Siegal's belief in the effect of positive and negative emotions on health is substantiated by findings of psychoneuroimmunology.

It is worth noting that Siegal does not believe emotion is only a brain process. Rather, he believes it is implemented by brain, body and social relationships. It is formulated contextually within the 'socially influenced, value-appraising processes' of the brain. In other words, emotion is not 'pure' in the sense of raw. It is not primal in the sense of animal nature. Emotion is value-appraising in the sense that emotions are positive when the evocative situation is perceived to be beneficent and negative when the evocative situation is perceived to be malevolent.[191] When the socially influenced, value-appraising processes of the brain are dysfunctional or not well developed due to dysfunctional, traumatic or absent infant-caregiver attachment or early chronic social stress, some or all of the functions and structures within the limbic system can be impacted. Below I consider the impact of social stress on functions of the limbic system.

The limbic system supports a variety of functions including emotion, behaviour, motivation, long-term memory, executive function, and olfaction. Limbic structures and functions co-mingle and integrate in complex, dynamic ways. Consider, for example, how

[191] Siegal's view of emotion agrees with enactivism in two respects. According to both, the nervous system does not process information in the computational sense but rather, creates meaning. In doing so, the nervous system spans brain, body and social context or lived experience.

an odour concurrently might precipitate a past memory and an emotion such as mirth or melancholy, lead to a train of thought and motivate certain behaviour.

For instance, let us imagine that the aroma is pleasant and evokes a memory of the childhood home, the pleasure of family dining. The family of origin are all dead, so the memories evoked are mixed and so are the emotions; happy memories and joyful emotions at the pleasure of the past camaraderie and melancholy thoughts and sadness at the present loss of family companionship. The appraisal mechanism registers the complex mixture of thought and emotion and if the memories, as a train of thought, evoke both joyful and melancholy emotions, they may motivate the viewing of the family photo album. However, if the melancholy thoughts and sad emotions are too uncomfortable, (the basins of attraction are deep in relation to the basins of attraction of happy memories and joyful emotions), and thoughts turn maudlin, the appraisal mechanism may shut down the train of thought and one may then seek distraction, in which case the family photo album may not be viewed.

In the language of dynamic systems, the thoughts and emotions are control parameters existing in metastability. The deeper the basins of attraction of specific parameters, the greater they influence the trajectory of thought, emotion and action through phase space. The depth of the basins of attraction of the respective thoughts and emotions may lead to a bifurcation in which one of the two actions are taken, either viewing the photo album or seeking distraction. The trajectory through phase space represents the thought, emotion and action processes.

Recall Bowlby's theory of attachment in which he believes attachment is a complex socioemotional system consisting of several subsystems operating interactively (see section 4.2). The infant's signals demonstrate the child's emotional state of mind. According to Siegal and Ainsworth, the caregiver's style of sensitivity in attuning to these signals serves the infant as an internal working model and thus as her basis of attachment.

> "Parental sensitivity is defined as a way in which a parent perceives the child's communication signals, makes sense of those signals by understanding their meaning for the child's internal mental world and then responds in a timely and effective manner to meet the child's needs…"[192]

[192] Siegel, D. (2012a). *Pocket guide to interpersonal neurobiology: An integrative handbook of the mind.* New York: Norton. 20-2.

In the case of the secure/autonomous caregiver, the child's communication signals are empathetically recognised and responded to accordingly. Conversely, if the attachment style of the of the caregiver is dismissing, the internal working model of the child likely to develop is avoidant. In the former case, caregiver and infant enter into 'neural resonance' in which each 'feels felt' by the other. Siegal refers to this state as *the neurobiology of we*. It is believed that this intimate connection facilitates healthy neural structural and functional development in the infant. Conversely, dysfunctional attachment relationships such as avoidant, ambivalent or disorganized attachment may create suboptimal or even dysfunctional neural development. The internal working model of attachment established early in life loosely creates the dynamic template which may serve to structure future interpersonal relationships.

There is evidence that emotion is plastic as are the underlying structures and functions of the limbic system. Both may be modified, either positively or negatively by experience. For example, severe and prolonged stress may have a negative impact on the limbic system whereas mild and transient stress may facilitate constructive plasticity.[193] Also, emotion may be intentionally modulated via several structures of the neocortex.[194]

Like emotion, memory is neurophysiologically multi-layered, complex and plastic. It is also interlinked with structures of the limbic system and is integral to social relationships.

> "[E}very thought we have, every word we speak, every action we engage in-indeed, our very sense of Self and our sense of connectedness with others- we owe to memory…"[195]

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[193] Etkin, A., Egner, T., and Kalisch, R. (2011). Emotional processing in anterior cingulate and medial prefrontal cortex. *Trends in Cognitive Science* 15(2). 85–93. doi:10.1016/j.tics.2010.11.004;
Chan T. et al. (2011). The role of the medial prefrontal cortex in innate fear regulation in infants, juveniles, and adolescents. *The Journal of Neuroscience* 31(13). 4991–4999
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3108443/pdf/nihms284844.pdf.
[194] Lutz, A., Brefczynski-Lewis, J., Johnstone, T., and Davidson, R. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PLoS ONE* 3(3).
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0001897;
Lutz, A., Greischar, L.L., Rawlings, N.B, Ricard, M. and Davidson, R. (2004). Long-term meditators Self-induce high-amplitude gamma synchrony during mental practice *PNAS* 101(46). 16369–16373.
https://www.pnas.org/content/101/46/16369.
[195] Squire, L.R., and Kandel, E.R. (2009). *Memory: From mind to molecules.* Greenwood Village, Colorado: Roberts and Company. ix.

Given the centrality of memory in social relationships and the bi-directional, recursive neural and psycho-social dynamics, it is appropriate to discuss memory now.

4.3.2. Memory

Memory is a self-organizing function, responsive to time, place and context. It may vary with mood, as even the same factual content might be remembered differently depending, for example, on whether one is joyful or depressed ,which demonstrates its relationship with emotion. The functioning of memory is vulnerable to suggestion and to stress. I will discuss mechanisms and components of memory and will describe the interlinking of some of these networks with the purpose of demonstrating that memory is a vital component of social relationship, usefully conceptualized as a functional, interdependent sets of dynamic processes. Thus, DST is a valuable tool in analysing and explaining this interdependence.

Siegal conceives memory broadly as "the way past events affect future function".[196] According to him, memory constructs the past, present and anticipated future and is influenced by external and internal factors. The brain evaluates and encodes experience in such a manner as to affect future responses. Earliest experiences are encoded by the *neural net* and cause patterns of activation, referred to as *neural net profiles*, which make it more probable that these patterns of activation will be repeated. The increased probability of firing again is caused by changes in the synaptic connections within the neural net. While the so-called representation may be stored in a particular area of the brain that initially was activated by the experience the representation is not a symbol, not a 'thing', but rather a pattern of neural activation. Thus, the notion of storage is somewhat misleading. According to Siegal, the specific pattern of firing (i.e. the energy flow within the neural net profile) contains information. Remembering is constituted by the increased probability of similar pattern of neural net firing and not by the storage of information in specific locations. As has been stated, "any two cells or systems of cells that are repeatedly active at the same time will tend to become 'associated' so that activity in one facilitates activity in the other."[197] Information is encoded via synaptic changes that regulate the flow of energy and

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[196] Siegal (2012). 46.

[197] Hebb, D. (1949). *The organization of behaviour: A neurophysiological theory.* New York: Wiley. 69-70.

is retrieved by activation of similar (but not necessarily the same) neural net profiles.[198] For short-term memory, chemical alterations strengthen connections of neurons. For the establishment of long-term memory, neural firing engages the epigenome to create protein needed for the creation of new synaptic connections (See section 3.4.1). In both cases, experience in an embedded context plays a crucial part in the structure and function of neural nets. In memory also the multi-scale interdependence of epigenome-brain-contextual experience is evident.

> "Recent work on plasticity in the sensory cortices has introduced the idea that the structure of the brain, even in sensory cortex, is unique to each individual and dependent on each individual's experiential history".[199]

Developmental and memory processes may be based on similar neural and molecular mechanisms of synaptic formation.[200] For example, when remembering a visual image (in the 'mind's eye' as it were), the visual cortex responsible for initially processing the image is re-activated. If the visual image when first seen was bound with other senses and emotions, these neural nets too may be re-activated in the process of recollection. An extreme example of this phenomenon may occur in the case of one who experiences post-traumatic stress syndrome (PTSD) in which a traumatic event or series of events is bound with extreme emotions and perceptions. In the most severe case, the event, together with accompanying emotions and perceptions, may be triggered as vividly as originally experienced (e.g. flashbacks). But even in less extreme recollections several neural net profiles may be engaged more or less simultaneously.

Distinct aspects of memory have been identified and described. *Implicit or nondeclarative memory* describes a form of memory in which there is no internal sensation of recollection but nevertheless there is behavioural, perceptual, somatosensory and emotional learning due to past experience. Implicit memory involves multiscale components of the brain that do not require conscious processing for encoding or retrieval. These are brain structures that are intact at birth. They include the amygdala and other

[198] Ibid. 47.

[199] Milner, B., Squire L.R., Kandel, E.R. (1998). Cognitive neuroscience and the study of memory, *Neuron* 20. 445-468.

[200] Siegal (2012). 47.

limbic structures for emotional memory, behavioural, somatosensory, and perceptual memory. In instances of implicit memory, neural nets automatically link in response to experience, for example, perception and emotion. Retrieval of implicit memory re-activates and biases aspects of everyday experience such as behaviour, emotion, perception, and somatosensory sensation. With repeated activation, implicit memories may become states of mind and over time, character traits. These memories form part of the subjective sense of ourselves and filter ongoing interpersonal and social experience. Typically, one may fail to recognize that implicit memory forms the foundation for these experiences.[201] However, it is possible to recognize the role of implicit memory in shaping one's experience in specific instances thereby making implicit memory explicit.

With repeated experience, the infant's brain detects similarities and differences in experiences and creates mental models or schema which are basic components of implicit memory. These are used to interpret experience and anticipate future experience. According to Siegal, mental models created by repeated experience are multimodal and contextually created. He gives the example of an infant who, feeling the shape of a nipple in their mouth, can pick out the familiar nipple visually.[202] Of course, this is a close analogue of the famous "Molyneux problem" so the matter may not be as straightforward as Siegal presumes but the point is that it is possible that mental models may incorporate more than one mode of perception.

The concept of mental model as an anticipatory device and shaper of the implicit Self fits well with the understanding of how an attachment model may impact an infant. Repeated experience of insecure attachment, for example, becomes implicitly encoded and tends to create an implicit memory of insecurity or perhaps even danger. These memories tend to unconsciously shape the child's development of self and relationship with others.[203] The

[201] Ibid. 51-52.
[202] Ibid.
[203] ***I***t must be borne in mind however that the evidence of a direct causal relationship between attachment behaviour and a child's self-development is dubious. Although controversial too, there is some evidence that genetics may also play a role. "The way we parent is not solely a function of the way we were parented as children… There also appears to be genetic influences on parenting… Klahr and Burt conducted a statistical analysis of 56 scientific studies from around the world on the origins of parenting behaviour, including some of their own. The comprehensive analysis, involving more than 20,000 families from Australia to Japan to the United States, found that genetic influences in the parents account for 23 percent to 40 percent of parental warmth, control and negativity towards their children… What's still not clear, however, is whether genes directly influence parenting or do so indirectly, through parent personality for example. Klahr said… The study sheds light on another misconception: that parenting is solely a top-down process from parent to child. While

point of discussing implicit memory is that it demonstrates the interdependence of interpersonal experience, neurobiology and personality. Implicit memory is an example of a complex, dynamic system spanning brain, body and world. Its creation may be conceived as bottom up process. Experience creates the neuronal interconnections. Once created however, implicit memories act to colour experience. This is a top down process. These two features act recursively and dynamically to stabilise implicit memory.

Explicit or Declarative memory may be categorized either as *semantic* (factual) or *episodic* (autobiographical). Explicit memory requires conscious awareness and focal attention for encoding. Whether something that is perceived will be remembered later depends upon a number of factors: the number of times it is repeated, its importance, one's ability to organize it and relate it to previous knowledge and the extent to which it is repeated (rehearsed).[204] The encoding of explicit memory also is a complex, dynamic process involving multiple neural and somatic structures and functions. It may also be conceptualized according to the schema of epigenome, neurophysiology (specifically neuroplasticity) and contextual experience. The enactivist approach and dynamic systems theory are well equipped to describe and explain both implicit and explicit memory.

In dynamic systems terms, the rehearsal of detail and other factors may act to stabilize memory. If the basins of attraction of all these parameters are deep, the trajectory through phase space represents the process of memory consolidation.

How parents and others interact with children in the elaboration of shared events seems to have an impact on the autobiographical memory and development of the self. Autobiographical memory is contextually bound, both socially and culturally. Initially content constituting autobiographical memory may be a part of working memory which is believed to be an emergent property of a network of brain regions including the prefrontal cortex. If the detail is mentally rehearsed, it may become encoded and become a more stable component of long-term memory. Permanent explicit memory requires further

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parents certainly seem to shape child behaviour, parenting also is influenced by the child's behaviour -- in other words, parenting is both a cause and a consequence of child behaviour." Michigan State University. Genes play key role in parenting: Children also shape parents' behaviour. Science Daily 20 March 2014. www.sciencedaily.com/releases/2014/03/140320101501.html.
Accessed 24 May 2017.
Klahr, A.S., and Burt, A.(2014). **Elucidating the etiology of individual differences in parenting: A meta-analysis of behavioural genetic research.** ***Psychological Bulletin*** 140(2). 544. doi:10.1037/a0034205

[204] Squire, L. and Kandel, E. (2009). *Memory: From mind to molecules* (2nd Ed.). Greenwood Village, Colorado: Roberts and Co. 74.

processing in the 'associational cortex', a process referred to as cortical consolidation. There it is available for linkages with other representations.[205]

Dynamic systems theory can model the complex process by which autobiographical memory becomes encoded as long-term memory. An episode is initially retained as working memory. Its basin of attraction is shallow. When it is mentally rehearsed and becomes a component of long-term memory its basin of attraction is deeper and the landscape in phase space changes accordingly. And if the episode is processed in the associational cortex its basin becomes deeper still and more stable. Again the landscape in phase space changes.

4.3.3. 'Dis-integrative' Chronic Social Stress

Stress is commonly considered negative, but this is not necessarily so. Physical exercise, for example, is a form of stress that may be beneficial. The pressure of studying for an upcoming exam may also be an example of "eustress" (positive stress) if it motivates one to focus attention more vigilantly. In this section, I focus on the negative aspect of stress as it impacts emotion and memory. Specifically, I will discuss the effect of interpersonal and social abuse and neglect on the developing mind of the child. The purpose is to demonstrate that chronic social "dis-stress" may cause the "dis-integration" of components of brain and body resulting in sub-optimal function, ultimately impacting interpersonal and social relationships. Dis-integrative chronic stress may impact the individual at multiple scales- epigenetic, neurophysiological (specifically neuroplastic), somatic, psychological and behavioural. This form of stress also operates across brain-body-environmental experience and be understood within the framework of the enactivist approach and DST.

There is evidence that childhood neglect and abuse, a form of chronic stress, puts one at increased risk for physical and mental illness later in life. Systemic chronic low-grade inflammation is thought to be ubiquitous and is suspected, when more serious, of contributing to a large variety of mental and physical diseases. However, the relationship amongst inflammation, stress and disease is not well understood. A study published in *Molecular Psychiatry* found increased levels of inflammation as evidenced by three blood

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[205] Ibid. 61-62.

biomarkers in adults subjected to either physical or mental abuse or neglect as children. In this study, childhood trauma was defined as sexual, physical or emotional abuse, neglect or separation from caregivers before the age of 17. The study was a meta-analysis of 25 previous studies and involved 16,000 subjects falling into three categories; healthy, physically ill and mentally ill. Different forms of trauma were thought to be associated with different inflammation blood biomarkers but at least one blood biomarker was considered an indication of generalized inflammation. Specifically, participants subjected to caregiver absence during childhood demonstrated increased levels of c-reactive protein (CRP), a marker for acute inflammation not specific to one disease but rather to several.[206]

The study supports Siegal's view that childhood trauma may lead to dis-integration of physiological processes, one of the markers of which is systemic inflammation. The following study elaborates the structural implications.

In another meta-analysis, Grassi-Oliveira, Ashy and Stein reviewed 29 studies which demonstrated an explicit link between abuse and neurobiological consequences. They concluded that:

> "Structural consequences of childhood maltreatment include disruptive development of corpus callosum, left neocortex, hippocampus, and amygdale; functional consequences include increased electrical irritability in limbic areas, frontal lobe dysfunctions and reduced functional activity of the cerebellar vermis; and neurohumoral consequences include the reprogramming activity of hypothalamus-pituitary adrenal (HPA) axis and subsequently the stress response."

They theorized that:

> "When allostatic response is excessive or inefficient due to abuse the organism develops an allostatic load… The cascade of molecular and neurobiological effects associated with childhood abuse and neglect could be an example of allostatic response that could precipitate allostatic load in an organism still vulnerable during its development."[207]

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[206] King's College London. Childhood trauma gets under the skin. *Science Daily*. 2 June 2015. www.sciencedaily.com/releases/2015/06/150602130422.html. Accessed on 11 April 2017.
Baumeister D., Akhtar R., Ciufolini S., Pariante CM., Mondelli V. (2016). Childhood trauma and adulthood inflammation: a meta-analysis of peripheral C-reactive protein, interleukin-6 and tumour necrosis factor-α D. *Molecular Psychiatry* 21. 642–649. Accessed 6 June 2017.
[207] Grassi-Oliveira R., Ashy M., Stein LM (2008). Revista Brasiliera de Psiquiatria 30(1). http://dx.doi.org/10.1590/S1516-44462008000100012. Accessed 6 June 2017.

This analysis suggests that when stress in the form of maltreatment overcomes one's coping mechanisms for an extended period of time, the neurophysiological response negatively impacts emotional, memory and executive limbic functions. But the impact is not limited to neural function as the acute stress response may bring about wide-ranging somatic, behavioural, interpersonal, and social consequences as well. In other words, childhood dis-integrative social stress demonstrates the causal interdependence amongst multiple scales of brain and mind-body-experiential context. Here we have another demonstration of circular causality wherein abuse causes neurological and psychological changes (upward causation) which in turn brings about physiological and social consequences (downward causation).

In an article entitled "Paradise Lost: The Neurobiological and Clinical Consequences of Child Abuse and Neglect", Nemeroff echoes the findings of research mentioned above. He states:

> "In the last decade, a remarkable concatenation of research findings has accumulated supporting the hypothesis that exposure to early untoward life events (early life stress [hence ELS]) in the form of child abuse and/or neglect is associated with a marked increase in vulnerability to major psychiatric and other medical disorders including major depression, bipolar disorder, post-traumatic stress disorder (PTSD), alcohol and drug abuse, and perhaps even schizophrenia, as well as obesity, migraines, cardiovascular disease (CVD), diabetes, and others. More recently, the biological and neurobiological consequences of ELS have been scrutinized in order to determine the molecular and cellular mechanisms that mediate the effects of ELS on the aforementioned disease vulnerability."[208]

"Allostasis is the process of achieving stability, or homeostasis, through physiological or behavioural change. This can be carried out by means of alteration in HPA axis hormones, the autonomic nervous system, cytokines, or a number of other systems, and is generally adaptive in the short term". McEwen, B. and Wingfield, J. (2003). The concept of allostasis in biology and biomedicine *Hormones and Behaviour* 43. 2–15. "Allostatic load is 'the wear and tear on the body' which accumulates as an individual is exposed to *repeated or chronic stress*. It represents the physiological consequences of chronic exposure to fluctuating or heightened neural or neuroendocrine response that results from repeated or chronic stress." Wikipedia: https://en.wikipedia.org/wiki/Allostatic_load. Accessed 7 June 2017 (italics added).

[208] Nemeroff, C. B. (2016). Paradise lost: The neurobiological and clinical consequences of child abuse and neglect. *Neuron* 89(5). 892-909. http://www.cell.com/neuron/fulltext/S0896-6273(16).00020-9?_returnURL=http%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0896627316000209%3Fshowall%3Dtrue. Accessed 6 June 2017.

It should come as no surprise that psychological trauma may result in an increased risk of psychological distress. More surprising perhaps is the research showing an increased risk of a wide range of physical problems associated with early life stress. However, this result should not be surprising when one considers that stress precipitates a range of epigenetic changes which may affect the genes other than those specific for the function of cognitive processes (See section 3.6). Indeed, the dissociation sometimes posited between genes, brain, mind, and body is inaccurate as has been shown by a raft of research in psychoneuroimmunology.[209] As regards the epigenetic factor, Nemeroff also weighed in. He considered the correlation between early life stress and epigenetic factors in disease vulnerability. He hypothesized that epigenetic factors both predisposed and moderated the severity of early life stress. He stated:

> "[T]here is now overwhelming evidence that epigenetic mechanisms are at the forefront of how early life experiences alter DNA expression, frequently over the lifetime of the organism. Early rodent studies unequivocally demonstrated that maternal care alters gene expression by persistent effects on DNA methylation, associated with a particular phenotype. From these early studies, a molecular model has emerged for how child abuse and neglect can result in increased risk for mood and anxiety disorders..."[210]

Gould et al. found similar structural and functional derangements as a result of early life stress and they were able to conclude that specific types correlated with specific types of problems. According to Gould, et al.:

> "[A] history of ELS is associated with altered neurocognitive functioning. Using cognitive test performance, it was possible to discriminate patients with ELS from healthy controls. Two dimensions emerged from the analyses. Specifically, the first dimension included visual memory, executive functioning, and spatial working memory. This dimension was strongly associated with both abuse and neglect with abuse exerting a slightly stronger effect. The second dimension was additionally associated with emotional processing/inhibition… Interestingly, the second dimension was most strongly associated with neglect. Due to overlapping group membership, these results do not suggest that abused children did not suffer from

[209] While an extended discussion of the impact of psychological dimension on immune and endocrine function is beyond the scope of this dissertation, it is worth noting that this relationship has been well documented and this is exactly what one would expect given the overall thesis of this dissertation.
[210] Nemeroff (2016).

> emotional processing deficits, but rather that there is a relatively stronger association of emotional processing impairments with neglect than abuse…"[211]

These four studies taken together lend strong support to the hypothesis that a broad range of early life social trauma, predisposes victims to an increased risk of a variety of mental and physical diseases and is correlated with a wide variety of cognitive and somatic dysfunction. Neurological, endocrine, psychological, epigenetic and undoubtedly other mechanisms (e.g. immune function) appear to be involved in complex, multi-scale, interdependent causal relationships which are usefully analysed with the tools of DST. Beyond the impact on brain and body, the consequences of childhood trauma extends into the world, impacting behaviour and social relationships. The enactive approach conceives these multi-scale relationships as constitutive of cognitive function. The cited studies demonstrate that the enactive approach is correct in this regard.

But the evidence also suggests that some of those subjected to the similar treatment do not suffer these effects. It has been suggested that epigenetic factors may be involved either to ameliorate the effects of ELS or to create a disposition to increased vulnerability. Duration of stress of course, chronic versus acute, is also a factor. Typically, it is chronic stress that causes the problems described above although severe acute stress may also have long-lasting effects. And no doubt, there several other contextual factors that determine whether physical or mental illness or both manifest. For example, a strong, supportive social network may help to alleviate the effects, whereas isolation may exacerbate the effects. Engagement in sport, music or other creative or social activities may also serve as a functional support. There may be a multiplicity of interacting factors that result in a beneficial or detrimental outcome, that no one factor alone could achieve. In other words, it is possible that many factors may interact to bring about the emergence of illness or health, over time. This suggests that these factors, as control parameters, could be used to create comparative phase portraits. If control parameters could be identified both for children who have suffered the effects of early life stress and children who have not, a comparison of the two groups could be performed using DST.

[211] Gould, F. et al. (2012). The effects of child abuse and neglect on cognitive functioning in adulthood. *Journal of Psychiatric Research* 46(4). 500–506.

As we saw in attachment, the energy and information flow in the mother-infant relationship is bi-directional and recursive. While this may be less in the case of neglect and abuse, there is also bi-directional and recursive elements here too as the victim either actively or passively responds to the abuser. We might think of allostatic load typically as the result of insufficiently mediated chronic stress. This stress may be dis-integrative at the scales of biology, personality and behaviour. A useful means to analyse and explain such a complex phenomenon is with the tools of dynamic systems theory.

4.4. Conclusion

In both infant-caregiver attachment and in social abuse, we have seen that at least different four scales are at play: epigenetic, neurological (specifically neuroplastic), psychological and social. These are related interdependently. Although the nature of the interdependence can be described differently at different scales, it is clear that the complex interactions amongst and within the scales render it minimally useful, from the dynamic systems perspective, to attempt to distinguish cause from effect as numerous control parameters interact. Nevertheless, methodologically this distinction may be useful from the third person perspective in reductionistic analysis as I have shown in the example of twin studies and in the nature-nurture debate.

Within each of these levels, multiple interactions may be discerned which make it reasonable to treat each level as a complex system. At the epigenetic level, it may be the case that individuals have inherited epigenetic predispositions. Additionally, epigenetic activity is activated and repressed as a result of interaction with the other levels. At the neurological level for example, the limbic system involves several neural structures which create complex interactions amongst emotion, memory and executive control. And at the level of interpersonal relationships, complex behavioural, emotional and cognitive interactions can be discerned. So, what we have are complex systems nested within complex systems. As far as I have been able to discern, no one has attempted to theorize the complexity of this inter-nesting, but this is what I am doing in a simplistic way by pointing out interdependences. In principle, dynamic systems is the tool of choice to analyse the complexity of these systems and the relationships between them. One challenge is to identify the relevant control parameters at each level and between scales. The precise detail I leave to others.

It seems clear from the evidence I have presented that so called top-down mental causation is well established. It has been demonstrated that cognitive faculties can be honed with meditative practice. The more practice in which one engages, the more robust one's cognitive capacity and correspondingly, the stronger the associated neural and epigenetic networks. For example, it seems reasonable to consider whether the most experienced meditative practitioners, those with practice hours in excess of 50,000, may have mastered the ability to control or perhaps even eliminate (as claimed by ITB) negative emotion. As I have emphasized repeatedly, bottom up and top down causation pair in what is more properly referred to as circular or bidirectional causality, a key feature of dynamic complex systems.

In the next two chapters, I once again expand the scale to consider the impact of technology on the mind. Specifically, chapter 5 is concerned with artefactual technology and chapter 6 examines the impact of phenomenological technology.

Chapter 5

Perturbation Co-equals Self-Organisation: Might Technology Co-organise the Mind?

5.0. Introduction

This chapter expands the scale of interaction between mind and social context, specifically focusing on technology, broadly construed. I use the term 'technology' to refer to "entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value".[212] Such a broad definition gives scope for all manner of creations and that is the point. Technology is inherently normative; it points to the cultural values embraced by society. The normative aspect becomes salient when I consider artefactual and phenomenological technologies in relationship.

The chapter differs from the previous four in that I project into the future, the conceivable development of technology, what it might take to bring it about, and the impact of development of these technologies on mind. Future projection, of course is speculative and presents challenges different from the previous chapters. One problematic difference is the uncertainty in what technological developments will drive change forward. There has been much speculation from philosophers, scientists and others as to whether a so called "knowledge explosion" (discussed below) will occur which some believe will drive technological developments to such unprecedented levels that humans may be able to supplant biological autopoiesis (in humans and other organisms) with technological self-organisation. That is to say, some believe that humans would be able, in the event of a knowledge explosion, to intervene in the self-organization of living organisms to impose an artificial self-organization. The inevitability of a knowledge explosion is controversial, but from our vantage point now, if it were to occur, the future of humanity would surely be unpredictable, perhaps unimaginable. Nevertheless, the tools of dynamic systems theory and enactivism are sufficiently flexible, in principle, to analyse even future developments

[212]Technology https://en.wikipedia.org/wiki/Technology.

since future developments will involve systems of interacting forces at multiple scales that change over time in mathematically describable ways.

In what follows, I discuss technologies currently available and consider what it might take conceptually to extend the sophistication of these so that they might, in theory, participate in co-organizing the mind. I then discuss more speculative artefactual cognitive technologies and consider how these might co-organize the mind. Artefactual cognitive technologies are those technologies which use devices, either directly or indirectly, to study or alter neural mechanisms and/or cognitive functions.

The purpose of the chapter is to demonstrate three theses: first, also at this expanded scale, technological factors establishing and maintaining mind cross the boundaries of skin and skull and extend to the contextual environment. As such, enactivism is a sound philosophical basis for considering the interdependence of mind-body-technology at multiple scales. These are dynamic systems even more complex than those previously considered. The second point is that even at the scale of technology, the tools of enactivism and dynamic systems theory can be used, in principle, to model and explain the complex dynamics establishing and maintaining mind. And finally, one can speculate about a couple of technological developments which could supplant biological self-organisation. The value of considering this possibility is that it is philosophically germane to consider what resources would be required to bring this about and to analyse it.

In this chapter the focus of interdependence is on the particular artefactual technology and its causal effect on the individual brain. The user of this technology is the person who directly interacts with it. Granted, others may be impacted by a given technology. For example, those technicians who administer it are affected but in a manner different, less direct, from the immediate user. And more distant still, all members of a society in which the artefactual technology is embedded may also be affected by it. For instance, the fMRI is used directly by a relatively small population but nevertheless it may have an indirect impact on the attitudes of the general population toward mental health by virtue of the manner in which it has shaped cognitive neuroscience, societal attitudes toward mental illness, mental health social policy and the law. However, such effects are outside the scope of this dissertation (with limited exception).

For example, consider the smart phone (for the moment ignoring the existence of other technologies) in its impact on the brain. In the case of the most frequent users, its neural impact may be significant because the human-technology interface is so frequent. If the smartphone causes neuroplastic changes to attention networks, then its basin of attraction is very deep.

I will reference both recent ACT developments and some speculative future developments (via thought experiments) which demonstrate the complex relationship between brain and the ACT. I will also focus, to a lesser extent in this chapter, on what I will refer to as phenomenological cognitive technologies (PCTs) which may also be employed to transform the mind. In the next chapter I will discuss PCTs in greater detail.

I am not concerned with whether or not these speculative ACT developments are actually realized; rather, I raise the question of what it would take conceptually to bring these about. I will explore the relationship of mind and technology not as a practical but rather as a speculative matter. The consideration of what artefactual resources would be required or useful to bring about substantial cognitive development throws light on the interdependence of mind and technology. And consideration of the relationships amongst knowledge drawn from multiple sciences likewise demonstrates these interactions and interdependencies. Since dynamic systems theory deals with the recursive interaction of multiple factors at multiple scales as a function of time, in principle it may be used conceptually to analyse possible bifurcations, transitions and phase portrait trajectories both artefactually and developmentally. In section 5.1 below, I present fMRI as an illustration of how artefactual cognitive technology may impact the individual.

5.1. Ramifications of the Development of fMRI on the Mind

Although as I said previously, it is not within this scope of this dissertation to discuss the impact of ACTs on those who are not direct users, nevertheless it would be remiss to not at least acknowledge its impact on nonusers. Therefore, I provide this example which illustrates the impact of one specific ACT, fMRI, in multiple arenas --personal, cognitive science, social attitudes and policy, and law. What all these have in common is that each arena, in the relationships between them and in the technology itself, may be analysed and explained by the same set of dynamic analytical tools. The reason this is so is because each scale and the relationships amongst them references dynamic, abstract relationships. This example illustrates complexity at multiple scales. And it also illustrates that multiple factors at many levels might cut across boundaries of brain-body-world.

Prior to the development of fMRI, the MRI was used to image the brain. It depicted static states of the brain and multiple images might have been taken with significant time intervals between images. Brain lesions and structural irregularities were depicted on these images and were thought to be one biological source of psychopathology (besides chemical and electrical dysfunction). With the development of the fMRI, multiple images were scanned in real time with intervals of fractions of a second. This device depicted dynamic, global activity of neural networks and a functional psychopathology could be visualised; the real time dysfunction of neural networks. This was a significant development at many levels. For example, the demonstration of biological causes of psychopathology (in part utilizing fMRI) has led to the recognition that more functional scanning data needs to be collected in order to reorganise the *Diagnostic and Statistical Manual of Mental Disorders* from symptom-based to biologically and functionally-based disorders.[213] This brings it more in line with the *Merck Manual of Diagnosis and Therapy*. The significance of this change is to lessen or eliminate the perceived gap between the mind-body relationship and also to move the dynamic conception of brain dysfunction into the clinical mainstream. This sea change has implications at several levels.

The recognition of a biological basis of mental disorder takes the personal stigma from mental illness, which in turn has led to the increased acceptance of MRI and fMRI by the general population.[214] It might be said that the development of fMRI constituted a phase transition from the recognition of psychopathology as a state (as depicted on MRI) to the recognition that psychopathology was a dynamic process (depicted on fMRI).

[213] Rosen, B. (2011). FMRI at 20: Has it changed the world? You tube video https://www.youtube.com/watch?v=edO43AT5GhE. Accessed 22 September 2019.
[214] Illes, J., Lombera. S., Rosenberg, J. and Arnow, B. (2009). In the mind's eye: Provider and patient attitudes on functional brain imaging. *Journal of Psychiatric Research* 43. 107-114.

FMRI has also had a significant impact on the development of cognitive science, facilitating a more sophisticated understanding of neural function. For instance, it has demonstrated the possible extent of global neuroplastic modification and has also shown that neuroplasticity is a time-dependent, dynamic process.[215] This recognition constitutes an alteration from the previously held view that the possibility neuroplastic modification was quite limited.

Several instances of fMRI's impact in a social context may be cited. For instance, social policy has been influenced by the utilization of fMRI. In the USA, a bill was introduced in 1996 in Congress requiring insurance companies to cover mental illness in parity with physical illness. Legislation mandating parity was finally passed in 2008. Senator Domenici offered fMRI images to demonstrate that a "broken brain" was the equivalent of a broken arm. Bruce Rosen said that in his interview with Senator Domenici's aides, this was the sort of data the senator had been seeking in order to make the case for the passage of the legislation.[216]

FMRI has also had a significant impact in legal matters. In the US Supreme Court case of Graham v Florida, the Court held that a sentence of life without parole imposed on a juvenile for a noncapital offence was a violation of the US Constitution's Eighth amendment prohibition against cruel and unusual punishment. The court relied on several research studies using fMRI to demonstrate that the juvenile brain was immature in several relevant respects. The majority opinion said in part:

> "It cannot be contested that important aspects of brain maturation, particularly those involved with the brain's executive functions remain incomplete even in late adolescence…
>
> "Developments in psychology and brain science continue to show fundamental differences between juvenile and adult brains. For example, parts of the brain involved in behaviour control continue to mature through late adolescence…

[215] Burton H. (2003). Visual cortex activity in early and late blind people. *Journal of Neuroscience* 23(10). 4005-4011.
[216] Rosen, B. (2011).

> "The biological basis for differences in juvenile conduct provides further support for the conclusion that less culpability should attach to juvenile conduct than similar conduct by adults."[217]

In DST terms, the development of fMRI has constituted a bifurcation in diagnostic scanning wherein MRI is used to depict static states of the brain and fMRI is used to depict functional processes in real time. This is not an either-or situation but rather a both-and situation according to which each instrument has its own domain of usage. This bifurcation has led to a phase transition in which there is a more sophisticated recognition of the role of neural networks in cognitive function. The development of this phase transition has been greatly facilitated by the deep attractor basin of media coverage which has popularized widespread awareness of the many uses of fMRI. Now, use of fMRI scans are commonplace by defendants in criminal cases.

Furthermore, there is a dynamic, bi-directional relationship amongst the personal, scientific, social policy, media, and legal arenas. As neuroscience continues to utilize fMRI to advance research and the media reports these advances, individuals' acceptance grows, and social policy and law utilises the technology increasingly. And conversely, the increased acceptance of fMRI as above will facilitate the technological development of this and other more advanced scanning tools.

Of course, the use of technology has always been a hallmark of what it is to be human. From the use of the club and spear to hunt, to the development of writing and language to communicate, from the manufacture of clothing to the development of computers, humankind has always employed tools to extend the mind and to enhance life. In this sense there is nothing special about the technological developments of the twenty-first century. Yet one might argue that the forthcoming technological revolution, which has already commenced, is different. Martin[218] discerns three epochs of evolution. In the first phase, *primary evolution*, mutation, drift, mixture and natural selection of the species are the mechanisms of change. After three billion years, multi-cell organisms developed from

[217] 560 US 48 (2010). Supreme.justia.com. Accessed 22 September 2019.
[218] Many individuals have created a plethora of futuristic technology scenarios, some pessimistic and some optimistic. Some of the others are Max Tegmark, Ray Kurzweil, Nick Bostrom and David Chalmers and some have discerned the anticipated evolution in terms of epochs for example, Martin, Tegmark, Aaron Bastani (Fully Automated Luxury Communism), and Luciano Floridi (The Fourth Revoution).

single cell organisms and homo sapiens evolved. *Secondary evolution* is the phase in which humans, in part, learn to create their own evolution. Machines, chemical plants, software, computer networks and transport systems are produced. Scientific methodology is established and utilized to create knowledge of the natural world and this knowledge is utilized to manipulate it. There is a great diversity of evolutionary tracks. Phase three, *tertiary evolution,* is just beginning, according to Martin. In this phase, humans learn to "automate evolution". What I take this to mean is that Martin believes that humans will create computers, that will utilize more sophisticated artificial intelligence than is currently available to "learn from experience" recursively, that is, to Self-evolve to the point where it reaches and eventually exceeds human intelligence. At present, AI is rather primitive in the sense that it performs rather rudimentary, well defined tasks referred to as machine learning. Examples include IBM's Watson Explorer which data mines, Google's Deep Mind which has healthcare applications and China's Infervison which can review CT scans for signs of cancer.[219] But great resources are currently being employed to make AI more sophisticated. According to Martin, phase three progresses to the evolution of procedures, control mechanisms and hardware which also has begun.[220] According to one scenario, evolutionary momentum builds through recursive iterations which accelerate and lead to what has been referred to as a "technological singularity". Clearly, this is highly speculative but there seems to be no lack of enthusiasts who are confident in this development.

The term 'singularity' has several meanings. Chalmers points out that technological singularity embraces two logically independent but related features, an ever-increasing level of intelligence in computing machines and an ever-increasing speed in information processing. If AI was to reach and exceed human intellectual capacity and if its artificial intelligence design is in the nature of human intelligence, then such a machine could design an AI machine smarter than itself and that machine could in turn design a machine smarter than itself recursively leading to what has been referred to as an "intelligence explosion".

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[219] https://www.forbes.com/sites/bernardmarr/2018/04/30/27-incredible-examples-of-ai-and-machine-learning-in-practice/#36590af17502. Accessed 21 April 2019.

[220] Martin, J. (2006). *The meaning of the 21st century.* London: Transworld Publishers. 180-181: See also Tegmark, M. (2017). *Life 3.0: Being human in the age of artificial intelligence.* New York: Alfred Knopf. Tegmark also discerns three phases of evolution which he designates as biological, cultural and technological. For both authors the phases are overlapping but each phase references a predominant mode of being in the world.

Separately but relatedly, if, hypothetically, computer processing speed was to double every two years as it has in the past, then if human-level AI designs new processors, then faster processing will lead to faster designers and an increasingly fast design cycle, leading to a watershed point referred to as the "singularity".[221] There are two related but separate points to this hypothetical; acceleration and singularity. The intelligence explosion assumes that acceleration is continuous and that continuity leads to the singularity.

There have been several suggested scenarios as to the transformation of societies and individuals in the event of a technological singularity. Most of these hypothesize a transformation with intelligence "infinite in all directions" that is, the application of ultra-intelligence in many areas of science and technology such medicine, neuroscience, and climate modelling. One extreme version predicts that:

> "Exponential technological progress [would bring] about such dramatic change that human affairs as we understand them today [would come] to an end. The institutions we take for granted… would not survive in their present form. The most basic human values… would be superseded. Our very understanding of what it means to be human—to be an individual, to be alive, to be conscious, to be part of the social order—all this would be thrown into question".[222]

A few examples of these extreme speculative transformations will be discussed in sections 5.6 and 5.7 below, namely uploading of the human mind and the elimination of age related biological and functional human deterioration, respectively.

In tertiary evolution as in secondary evolution, diverse sciences and technologies intersect and scale up to create synergistic results. One significant difference between the secondary and tertiary phases is the pace at which evolution takes place. For example, one may speculate that nanotechnology might eventually create nanoscale computer chips greatly enhancing computing power. AI software might eventually be on a par with or exceed human intelligence and continue to develop and self-evolve through recursive iterations, ever deepening its intelligence. These developments may, in turn, allow the computation of increasingly large data sets which may bring about greater knowledge of genetic and neuroscience mechanisms, processes, and patterns leading to breakthroughs in

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[221] Chalmers, D. (2010). The singularity: A philosophical analysis. *Journal of Consciousness Studies* 17(9-10). 7-65.
[222] Shanahan, M.(2015). *The technological singularity.* Cambridge, Mass: MIT Press. Xv.

medical science, technology, and treatment. In Section 5.6 below I discuss current research in the science of aging (biogerontology) by Aubrey de Grey and others.

It is noteworthy that these speculative changes most likely would not happen serially but rather in parallel, dynamically. That is, mechanisms of change such as technological developments, scientific advances and cultural conditions, either large or small, initially advance independently but late coalesce with others creating control parameters which evolve change in many intersecting sciences and technologies. In this context, control parameters refers to those mechanisms of change that play a part in one or more trajectories resulting one or more phase portraits. These changes, in turn, feed-back as recurrent loops, constituting constraints on the mechanisms of change; the well-recognized bidirectional causality. In the speculative singularity scenario, the synergistic relationships of several sciences, technologies and cultural conditions result in the emergence of unimagined knowledge and cognitive artefacts. Multiple components of scientific, technological and cultural transformation demonstrate that dynamic systems theory is an important tool to analyse these dynamic relationships at multiple scales.

5.2. Artefactual Cognitive and Phenomenological Cognitive Technologies

I distinguish two types of cognitive technology, artefactual and phenomenological. As previously mentioned, ACTs are those which use devices, either directly or indirectly, to study or alter neural mechanisms and/or cognitive functions. For example, functional magnetic resonance imaging (fMRI) is used to study neural activity in real time.[223]

Another example of an ACT is the neurofeedback device which provides the user with the means to alter neural oscillations which, in the context of therapy, are correlated with functional and dysfunctional cognitive states. The device commonly uses an electroencephalograph (EEG) to present the user with a real-time computer display, in user-friendly format, correlated with patterns of their neural activity. The user begins with their baseline patterns and is challenged to achieve another display correlated with more

[223] Technically, fMRI does not directly track neural activity. Rather, it detects changes in blood oxygenation . Increased neural activity consumes more oxygen and blood flow increases to meet the demand. Open University. How fMRI works. https://www.open.edu/openlearn/body-mind/health/health-sciences/how-fmri-works. Accessed 6 December 2019.

desirable or functional cognitive states. They learn how to modulate neural function through regular training.

Thus, there is a dynamic interplay in real time between the device and the user. Eventually the user may be able to regulate neural activity without the device. I will discuss neurofeedback in greater detail in Section 5.3.4. below.

ACTs augment the ability to analyse or alter neural function and as such, may both advance neuroscientific knowledge and provide therapeutic resources. One weakness of ACTs is that the insights gained, or benefits received will be limited to the capabilities of the technology. Thus, there is a need continually to advance the technology. This dynamic of continual looped feedback is both an advantage and disadvantage as the technological limitations provide impetus further to advance ACTs. Thus, there is a dynamic feedback mechanism at play between the advance of neuroscientific knowledge and development of ACTs. In the case of fMRI, advances have led to the doubling of imagery resolution about every 18 months which has, in turn, lead to greater understanding of the functions of neural networks but it has also demonstrated that further enhancements to resolution are needed. It has been anticipated that future enhancements will allow resolution to the level of individual neurons and synapses, which will provide still greater knowledge of neural and network functions.[224] This knowledge will be important in the creation of maps of the brain[225] operating at the scales of the neuron, local and global networks. In turn, this will allow the development of more sophisticated ACTs. Again, we have an example of bi-directional feedback loops operating in the dynamic interdependence of ACTs and scientific advancement.

Phenomenological cognitive technologies (PCTs) are those techniques that use perceptual and cognitive faculties to introspect, observe and alter cognitive function. Meditation, phenomenological epoché and psychotherapies such as cognitive behavioural therapy (CBT) are examples. In the next chapter, I will discuss meditation in detail. Different forms of meditation utilise various cognitive functions: to focus attention, to enhance traits such as compassion and egolessness and to allow the mind to stabilise in its

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[224] Martin (2006). 213.
[225] The Human Connectome Project is such an endeavour. See http://www.humanconnectomeproject.org.

‘natural state’.[226] And there are technologies that combine the artefactual and phenomenological. For example, neurofeedback devices also require the experiential participation of the user.

A further distinction based on accessibility may be made between these two forms of cognitive technology. Sophisticated ACTs are limited in accessibility in that the availability of these requires a certain socio-cultural framework (insurance coverage, first world finances, highly trained medical staff, expensive equipment, etc). PCTs provide virtually unlimited accessibility in the sense that the means to investigate experiential phenomena are always available although it is said to be important to have guidance of a teacher. The philosophical importance of the distinction between the two technologies is both epistemological and ontological. A society steeped in ACTs tends to rely on and value such technology-assisted means of mediating the world. Technology then colours what is believed to exist. In contrast, a society predominantly utilizing PCTs values unmediated experience which alone colours their ontological view of the world. As further discussed in the next chapter, the Indo-Tibetan Buddhist utilisation of PCTs plays a crucial role in the structure of their epistemological and ontological framework, specifically the understanding of mind and death.

One might legitimately ask what the purpose of this distinction is and in fact whether it is a useful one. After all, both forms of technology may be used to study and alter the mind. One reason I make this distinction is that advanced PCTs may provide information that ACTs alone do not, or perhaps cannot provide or PCTs may bring about unexpected or even anomalous results.[227] For example, gTummo yoga, an advanced meditation and breathing practice, enables practitioners intentionally to alter peripheral body temperature.[228] Scientifically researching the functional mechanisms involved may add to the understanding

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[226] Natural state of mind or “nature of mind” is a concept used in Indo-Tibetan Buddhism to refer to “pure” awareness unadorned with thought, concept or language. This concept will be discussed in the next chapter.

[227] I am not claiming that ACTs cannot provide cognitive modification. For example, the Tactile Visual Sensory Substitution device (TVSS) has been used by Paul Bach-y-Rita to enable visually impaired or blind individuals to ‘see’ by substituting tactile for visual information. Rather, the claim is that there may be *instances* in which PCTs may provide information that ACTs do not or perhaps cannot provide.

[228] Benson, H., *et al.*(1982). Body temperature changes during the practice of g Tum-mo yoga. *Nature* 295. 234–236. doi:10.1038/295234a0.

of mind-body regulation of autonomic functions. With such information, ACTs may then be designed to assist individuals to regulate somatic functions themselves.

Furthermore, PCTs provide phenomenological data that ACTs cannot provide, namely first-person experience of consciousness. While ACTs may provide data on the neural correlates of experience, they cannot provide insight into the phenomenological aspect. As Varela, Thompson and others have argued, correlating both phenomenological and objective data gives a more complete picture of consciousness.[229]

As argued above, there may be a dynamic interplay between ACTs and PCTs (e.g. neurofeedback) which could result in an increased understanding of cognitive and somatic functions. Another example is the use of fMRI to monitor the neural activity of advanced meditators accompanied by reports they provide of their meditative experience. Of particular note is that this interplay demonstrates that intentional techniques may be used to modify neural structures and autonomic functions long thought to be beyond wilful control. Correlating phenomenological and objective data gives a more complete picture of how this result arises. And from the dynamic systems perspective, PCTs could be control parameters in the development of ACTs insofar as PCTs could act as catalysts in developing ACTs to investigate anomalous data arising from PCTs.

5.3. Brain-ACT Interfaces

Brain computer interfaces (BCIs) provide the brain with new input and output channels that depend on brain activity rather than on peripheral nerves and muscles. BCIs can, for example, provide communication and control, in which the user's intent is decoded from electrophysiological measures of brain activity. Neural activity is recorded noninvasively by sensors on the scalp or invasively by electrodes placed on the brain surface or within the brain. BCIs can enable people who are severely paralyzed to communicate their wishes,

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[229] Varela, F. and Shear, J. (Eds.). (1999). First person accounts: Why, what, and how. In *The view from within: First person accounts to the study of consciousness*. *Journal of Consciousness Studies* 6 (2-3). 1-14;
Lutz, A. and Thompson, E. (2003). Neurophenomenology: Integrating subjective experience and brain dynamics in the neuroscience of consciousness. *Journal of Consciousness Studies* 10(9–10). 31–52.

operate word processing or other computer programs or even control a neuro-prosthesis. And deep brain stimulation has been used for therapeutic purposes in Parkinson's disease.

The development of interface between the brain and artefactual cognitive technologies is currently in a rudimentary stage. This is due both to insufficient in-depth neuroscientific understanding as to brain function and lack of sufficiently sophisticated technology. However, there is little doubt that as neuroscience advances and technology develops, the interfaces will become more sophisticated and useful for a plethora of purposes.

5.3.1. Cochlear Implant

The cochlear implant (CI) is an excellent example of a BCI. It has been in existence for many years. Typically, the development of technology has occurred in several stages over a long time period, involving many researchers who have scaffolded the work of colleagues and predecessors. This has been the case with the cochlear implant. Although Merzenich et al. were by no means the first to develop the CI, they have advanced the understanding of the plasticity of the auditory cortex. This work is philosophically significant, so I focus on it now.

The CI is a device surgically implanted in the inner ear that electrically stimulates the cochlear nerve by a threadlike array of electrodes. At the time of Merzenich et al's investigation, the CI delivered electrically encoded patterns from the ear to the brain that crudely simulated the more refined patterns delivered by the intact ear. In the early development, words spoken be a third party were not intelligible to the user of the CI. Merzenich discovered that if users themselves spoke and listened to what was spoken, they developed the ability to hear words spoken by others more clearly. We may speculate that this is a demonstration of neural plasticity. Attempting artificially to create electrically encoded patterns of speech was not successful; rather self-created looped feedback was. In the case of an individual who lost their hearing later in life, they had memories associated with the auditory cortex. These associations were utilized, in part, to regain hearing.[230] Recursive looped feedback has been at the heart of the enactivist schema of sensorimotor perception. It unifies brain, body and environmental context (including experience),

[230] Merzenich, M.(2013). *Soft-wired: How the new science of brain plasticity can change your life.* San Francisco: Parnassus Publishing. 23-28.

creating a complex, dynamic system. In the case of the CI, recursive looped feedback was necessary to refine auditory perception.

Each of the required functions of hearing is associated with multiple networked structures, but for the sake of simplicity we can crudely describe the neural reorganization required to regain CI-assisted hearing. The functions involved in regaining CI-assisted hearing, according to Merzanich's research, were memory and memory associations, speaking ability, reading ability and hearing. After the loss of hearing but with the aid of the CI, Broca's area on the left frontal lobe (speech processing)[231], the temporal lobe (responsible for discriminating sounds),[232] Wernicke area (language comprehension)[233] working in conjunction with the auditory cortex (hearing)[234] and the hippocampus[235] (memory processing) recursively looped and so allowed the brain to reorganize the multiplicity of connections necessary for the auditory cortex to regain function.

From this example, we see that the named brain structures coordinate function by recursive looped feedback over a period of time to reorganize the structure and function of the brain in order to create the ability to hear clearly. Recursive looped feedback over time results in neural plasticity, accommodating the integration of the brain within the environmental context. This is a complex, dynamic process that cannot be replicated merely by replicating the electrical signal (of speech) to the CI. In the terminology of DST, each of the named structures and functions are control parameters and coordination variables with deep basins of attraction that must coordinate function in real time. Successful coordination together with healthy functioning structures, results, in time, in a trajectory through phase space that represents clear hearing. However, if one or more of the control parameters are dysfunctional or if coordination amongst the functions is suboptimal, the resulting trajectory through phase space will be skewed away from the trajectory representing optimal function. Presumably different trajectories would be

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[231] https://neuro.hms.harvard.edu/harvard-mahoney-neuroscience-institute/brain-newsletter/and-brain-series/reading-and-brain. Accessed 21 April 2019.
[232] Ibid.
[233] https://www.thoughtco.com/wernickes-area-anatomy-373231. Accessed 21 April 2019.
[234] https://www.ncbi.nlm.nih.gov/books/NBK10900/. Accessed 21 April 2019. For more detail, see Kandel, Schwartz and Jessell (Eds). (4th ed. 2000) 590-622.
[235] http://www.human-memory.net/brain_parts.html. Accessed 21 April 2019.
For more detail, see Kandel, Schwartz and Jessell (eds.). (4th ed. 2000). 1227-1277.

demonstrated for each of the suboptimal functions and perhaps these 'suboptimal trajectories' could be used as a diagnostic tool.

5.3.2. Cardiac Pacemaker

Another example of artefactual technology is the cardiac pacemaker. While this device currently is not an ACT[236], one can speculate as to how it could become such. Currently, the cardiac pacemaker has a computer which monitors cardiac rhythms and directs a generator to send electrical impulses to the heart when necessary to correct cardiac arrhythmias. Newer pacemakers can also monitor blood temperature, breathing and other factors and adjust the heart rhythm if necessary according to the body's demands.[237] However, the computer neither diagnoses nor corrects the cause of arrythmias. Heart failure is notably caused by impaired parasympathetic responsiveness and sympathetic hyperactivity. An ACT which monitors and corrects both can be imagined. The cardiac pacemaker might become an ACT by interacting with the vagus nerve, the tenth cranial nerve.[238]

Dynamic systems theory may be employed at two different scales to 1) describe the trajectory in phase space that constitutes the process of development of this ACT and 2) describe the trajectory in phase space that constitutes the interdependence of coordination and control variables governing the operation of this ACT once developed.

With regard to 1 above, the following are a few control and coordination variables: all the knowledge necessary to create such a device: all the technology needed to create such a device; all the personnel needed to develop, test and market it; the financial wherewithal to develop, test and market it; market demand; self-organised coordination of all control variables. The process of development, testing and marketing the device could be represented by a trajectory through phase space. A point on this trajectory represents the

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[236] A cardiac pacemaker has no cognitive function presently so it cannot be deemed to be an ACT. However, since the heart is innervated, in part, by the vagus nerve, one can speculate what it would take to create a cardio-vagal connection. Varela et al might differ from this view. Given the mind-life continuity thesis and the vital role of the cardiac pacemaker in sustaining life, they might argue that the technology is minimally cognitive.

[237] https://www.nhlbi.nih.gov/health-topics/pacemakers. Accessed 21 April 2019.

[238] Kalla, M., Herring, N., and Patterson, D. (2016). Cardiac sympatho-vagal balance and ventricular arrhythmia. *Autonomic Neuroscience* 199. 29–37. doi: 10.1016/j.autneu.2016.08.016 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5334443/. Accessed 2 November 2019.

state of development of this process at a moment in time. Assuming adequate coordination of control variables and adequate and balanced basins of attraction (neither too deep nor too shallow) of all control variables, the device would be developed, tested and marketed. The value of dynamic systems analysis in this case is to evaluate and explain the relative strengths and weaknesses of the individual control parameters.

With regard to 2, the following are a few control and coordination variables: monitoring and regulation of heart's internal pacemaker (not the ACT), monitoring and regulation of sympathetic and parasympathetic nerve function relative only to the control of cardiac function; coordination of these three functions; monitoring, regulation and coordination of any other neural and somatic functions interacting with or regulating either or both of these; Self-organised coordination of all control variables (which requires recursive, looped feedback). The trajectory through phase space would represent the ongoing operation of the ACT in real time. Adequate coordination of all the variables and balanced basins of attraction of all variables would result in a trajectory through phase space representing adequate function.

5.3.3. Ocular Lens Implant

Similar to the cardiac pacemaker, the ocular lens implant is currently not an ACT in that it does not directly interface with the oculomotor nerve (cranial nerve III) but again, one can imagine that such an interface could be developed. What would be required to make the artificial ocular lens implant an ACT? One avenue would be for the oculomotor nerve directly to control the ciliary muscle which in turn would adjust the focal length of the lens. What might be required for such an interface?

The natural lens has a bidirectional feedback mechanism with neuromuscular structures that control it. In principle, one can imagine what it would take to replace these functions with an ACT. Standard cataract treatment removes the obscured natural lens and implants an artificial lens. Since all other ocular and related structures and functions are unaltered, dynamics of visual perception need not be considered, but if the ocular lens were to become an ACT, the dynamics of vision would need to be considered and are described below.

The natural lens is connected at its outer rim to the ciliary body by ligaments called zonules. Muscles in the ciliary body stretch or relax to enable the flexible lens to alter its shape and allow the eye to focus on objects at varying distances. Muscles of the ciliary body are innervated by the oculomotor nerve and accommodation of the lens for varying focal lengths requires the innervation of this nerve. A lens functionally equivalent to the natural lens would accommodate and dynamically adjust focal length continuously in a manner functionally equivalent to the natural lens, responding to the visual demands of the user in real time. This might require a connection to or communication with the oculomotor nerve and coordination with other neural connections would need to be considered as well since visual perception is a complex, dynamic process. Consider that seeing requires "attending", at least in some instances. This is an intentional act in which effort is required and 'meaning' in some respect attaches to the perceived object. There may be a normative component since the perceived object is deemed worthy of attention. So, in addition to innervation of the oculomotor nerve, coordination with certain higher cognitive functions might be required as well. A recursive feedback mechanism between higher level and lower level cognitive functions would be required to operate unimpeded and it would be required to operate in real time. In this dynamic process, multiple neural structures and functions must be coordinated as well. If such an ocular lens were to be developed, the dynamics of seeing, attending and other higher cognitive functions would need to be coordinated. As we have seen with the cochlear implant, such coordination would rely on the self-organization of the brain and structures of vision (via recursive bidirectional feedback). Neural structures modulating attention, meaning and value would then act 'downwardly' to affect 'lower level' somatic, neural and artificial structures.

Within the framework of DST, the development of such an ACT would roughly follow the DST framework for the development of the cochlear implant described above although of course, the specific parameters would be different. Again, dynamic systems theory may be employed at two different scales to 1) describe the trajectory in phase space that constitutes the development of the ACT and 2) describe the trajectory in phase space that constitutes the interdependence of coordination and control variables that govern operation of the ACT once developed.

With regard to 1 above, the following are a few control and coordination variables: all the knowledge necessary to create such a device: all the technology needed to create such a device; all the personnel needed to develop, test and market it; the financial wherewithal to develop, test and market it; market demand; self-organised coordination of all control variables. The process of development, testing and marketing the device could be represented by a trajectory through phase space. A point on this trajectory would represent the state of development of this process at a moment in time. Assuming adequate coordination of variables and adequate and balanced basins of attraction (neither too deep nor too shallow) of all variables, the device would be developed, tested and marketed. The value of dynamic systems analysis in this case is to evaluate and explain the relative strengths and weaknesses of the individual parameters.

With regard to 2, the following are a few variables: regulation and coordination of all visual and cognitive functions (such as innervation of the ciliary muscles by the oculomotor nerve and neural links to lower and higher cognitive structures e.g. visual cortex, prefrontal cortex respectively) and Self-organised coordination of all variables (which requires recursive, looped feedback). The trajectory through phase space represents the ongoing operation of the ACT in real time. Adequate coordination of all the variables and balanced basins of attraction of all variables would result in a trajectory through phase space representing adequate function.

5.3.4. Neurofeedback Device: A Mixed Artefactual and Phenomenological Cognitive Technology

The neurofeedback device is a non-invasive therapeutic intervention that provides a computer-brain interface registering real-time neural oscillation activity correlated with a user-friendly visual or auditory display. Its purpose is to assist a user in modifying their neural oscillations from the user's baseline, which is a pattern representing a dysfunctional neural oscillation to a pattern representing a functional oscillation. Typically, the user sees a picture on a monitor which represents and is correlated with the dysfunctional neural pattern. The task of the user is to modify the display to another display representing the desired neural pattern. When they are successful, the user is required to maintain that display. The principles of upon which the ACT relies are neuroplasticity and operant conditioning, involving positive and negative feedback loops. When they are successful, a display associated with the desired neural oscillatory patterns (and correlated with "functional" cognition) is provided and the user is required to maintain that display. This display constitutes positive feedback. Conversely, when the user is unsuccessful in achieving the desired neural patterns, they are provided with a different display which constitutes negative feedback and they are required to change it to the desirable display.

For example, if neurofeedback is used to modify the experience of central neuropathic pain (CNP), the display presented to the user might be flames which is a user-friendly depiction of the neural correlate of hyperactivation of the sensorimotor cortex. The height of the flames might be correlated with the degree hyperactivation (pain); the greater the activation, the higher the flames. The user attempts to lower the height of the flames. They are in fact downregulating specific bandwidths correlated with the hyperactivation.

Neurofeedback has been used successfully to control the experience of pain. For example, in a small sample study, Hassan *et al.* showed that in up to forty sessions of neurofeedback six out of seven patients rapidly lowered the experience of pain and four of the seven retained the benefit longer term.[239] Several neural functions may be involved, for example, pain processing, pain perception, pain memory, and the psychological and emotional components of pain. Neurofeedback can alter the connectivity between regions of the brain that control and coordinate these functions.[240]

DST may be employed to describe the dynamic processes according to which these changes take place and the manner in which they may be modified. When each of the components mentioned above are involved in the experience of pain, each has a deep basin of attraction which represents its contribution to the overall experience of pain. The parameters operate both independently and jointly to create a complex, dynamic experience of pain which may be represented by a trajectory through phase space. When the basin of attraction of neurofeedback is sufficiently deep, it is a variable that may cause

[239] Hassan, M.A., Fraser, M., Conway, B.A., Allen, D.B. and Vockovic, A. (2015). The mechanism of neurofeedback training for treatment of central neuropathic pain in paraplegia: A pilot study. *BMC Neurology* 15. doi: 10.1186/s12883-015-0445-7. https://www.ncbi.nlm.nih.gov/pubmed/26462651.
[240] Adaes, S. Neurofeedback therapy for the management of pain. https://brainblogger.com/2016/05/27/neurofeedback-therapy-for-the-management-of-pain/.

the basins of attraction of one or more components of pain to become shallower, thereby creating an altered trajectory through phase space representing relief from the experience of pain.

Alteration of the basins of attraction of one or more components of pain alters the trajectory which represents the ongoing sensation of pain. Since components of pain operate jointly as well as individually, it may not be necessary to affect the basins of attraction of all the components because alteration of one or more may be sufficient to diminish the experience of pain.

In neurofeedback therapy, multiple neurofeedback sessions are provided in which the user progressively learns to modify neural patterns correlated with dysfunctional cognitive states and replace these with functional patterns. In the process of the training, the user implicitly learns "what it is like" to be in the desired neural state correlated with functional cognition. And if they are successful in doing this, they may eventually learn to achieve this desirable neural state without the use of the device. Neuroplastic modification constitutes success; neural network connections correlated with dysfunctional cognitive states are modified or eliminated and new connections correlated with functional states are created. These structural changes are created by "higher level" intentional mental processes such as attention, and intention "acting downwardly" or more accurately, circularly and recursively to modify "lower level" mental processes such as those correlated with various components of the experience of pain.

Research conducted at the University of London in 2010 provided some basis for the belief that neurofeedback holds promise in modifying neural activity post treatment. It provided the first evidence of neuroplastic changes occurring directly after neurofeedback training. The researchers demonstrated that half an hour of voluntary control of neural oscillations was sufficient to induce a lasting shift in cortical excitability and intracortical function. They utilised non-invasive transcranial magnetic stimulators (TMS) to investigate whether any tangible changes in cortical function took place shortly after a single session of self-regulation. This was done by applying a short magnetic pulse externally to the scalp to stimulate the motor cortex, producing a muscle twitch which was proportional to the level of neural responsiveness ("excitability") of the cortex. They observed that the cortical response following the neurofeedback session was significantly enhanced and accompanied by a disinhibition of intracortical synaptic function. Such after-effects persisted for at least 20 minutes following termination of training, a period indicative of neuroplastic change. [241]The researchers concluded:

> "Our findings provide evidence that [Brain-computer interface] control of natural human brain rhythms leads to sustained (at least 20 min) changes in motor cortex excitability. They provide support for the view that network oscillations are unlikely to be epiphenomenal and that they may lead to changes in cortical function that outlast their phase of entrainment. Thus, brain oscillations could be an additional mechanism harnessed by the brain to mediate plasticity".[242]

This research suggests that even a single short period of neurofeedback training, that is modification of neural oscillations, may cause modifications to neural function that have enduring effect. This ACT operated jointly with PCT was able to effect long term cognitive change. However, it is not clear whether the neural control is the cause of the modification or just accompanies it. The researchers suggest it is likely that the neural control exerted had causal efficacy and therefore, it is likely that is not epiphenomenal. The reference to epiphenomenalism refers, I believe, to the view that conscious control is causal and can act 'downwardly' to modify motor cortex excitability.

Neurofeedback training as a means of reconfiguring neural function and modifying neural structure is not without its critics. For example, a Psychology Today blog referenced a meta-analysis of 13 randomized studies which concluded that:

> "Evidence from well-controlled trials with probably blinded outcomes currently fails to support neurofeedback as an effective treatment for ADHD".[243]

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[241]Science Daily. First direct evidence of neuroplastic changes following brainwave training. https://www.sciencedaily.com/releases/2010/03/100310114936.html. Accessed 26 February 2019.

[242] Ros, T., Munneke, M.A.M., Ruge, D., Gruzelier, J.H. and Rothwell, J.C. (2010). Endogenous control of waking brain rhythms induces neuroplastic changes in humans. *European Journal of Neuroscience* 31(4). 770-778; 776. https://onlinelibrary-wiley-com.ucc.idm.oclc.org/doi/epdf/10.1111/j.1460-9568.2010.07100.x. Accessed 26 Feb 2019.

[243] Jarrett, C. (2016). Read this before paying $100's for Neurofeedback Therapy. *Psychology Today* https://www.psychologytoday.com/us/blog/brain-myths/201302/read-paying-100s-neurofeedback-therapy . Accessed 21 February 2019.

The updated blog referenced two 2017 papers claiming that the treatment benefit from neurofeedback was no greater than that provided by the placebo effect.[244] Presumably the point of referencing the placebo effect was to say that no benefit additional to the placebo effect could be discerned. While the mechanism of the placebo effect is not well understood, one view is that a treatment or drug has a beneficial effect because the subject believes it will. In this instance, it is thought that the belief has a “downward” effect on the body. Drug trials and experiments routinely use double blind studies to eliminate the possibility of this effect. It should be noted that the placebo effect is so strong that medical doctors have used it from time to time (notwithstanding the potential ethical concerns).

Nevertheless, it is my view that neurofeedback will be shown more conclusively to produce neuroplastic changes and to be an effective therapy for a variety of neurological and mental conditions. What this may require is advances in decoding network oscillations, a greater understanding of the mechanics and applications of neuroplasticity and further development of neurofeedback techniques and technology. For example, real time fMRI has been shown, in one research study, to be more effective than EEG-based neurofeedback in modifying neural connectivity.[245] Both are ACTs the operation of which can be analysed and explained using DST.

My optimism is based on the fact that, while the principle of neuroplasticity is well established, its application to the treatment of neurological dysfunction and mental disturbance is in the early stages of investigation. Specifically, its mechanisms, control parameters and the amount of time needed for paring of dysfunctional networks are not well understood mechanisms, control parameters and the amount of time needed for paring of dysfunctional networks are not well understood.

5.4. Virtual Reality and Immersive Virtual Reality Technologies

There are two overlapping tracks in the development of virtual reality technology (VRT); VRT and immersive VRT (IVRT). VRT simulates experience similar to or different from that of

[244] Ibid.

[245] deCharms, R. C. et al. (2005). Control over brain activation and pain learned by using real-time functional MRI. *Proceedings of the National Academy of Sciences* 102(51). 18626-18631. https://doi.org/10.1073/pnas.0505210102. Accessed 29 September 2019.

the real world. Developments in VRT strive toward ever deeper immersion of the user in the virtual world. The ultimate goal is to create virtual reality experiences in which one perceives oneself to be fully immersed in a virtual reality context as if one was physically present in that non-actual world. The ideal presumably is that there would be no need for a user to suspend disbelief about their contextual experience. Immersion itself is a complex process which can be divided into four categories: sensory-motoric immersion, cognitive immersion, emotional immersion and spatial immersion. In turn, these can be further subdivided. For example, cognitive immersion can be parsed into tactical, strategic and narrative immersion. It should be noted that phenomenological immersion is not listed, perhaps because it is assumed that it arises when the other types of immersion are successfully accomplished.

Currently VRT sometimes uses the language of immersion but this seems to be a marketing ploy rather than a legitimate description of what is actually being experienced. However, each enhancement seeks to create deeper immersive experience. Ongoing research and technological developments are attempting to replicate each of the five senses in virtual reality.

VRT has been attempted in the past but has only recently gained momentum as gaming computers have become sufficiently powerful to present enhanced graphics. On the other hand, actual IVRT has not been developed yet, although progress toward IVRT is being made as enhancements designed to engage all the senses are being made. I will describe the impact of VRT and IVRT both in the present and as anticipated in the future.

Currently, VRT is also in the early developmental stage and is utilized, for the most part in gaming, but therapeutic options are also being explored. A headset, operating in conjunction with a powerful computer and software, is used to create the illusion of an environment in virtual reality by utilizing 3D visual perception with stereo sound effects. One or more additional senses may also be stimulated consistent with experience in that environment. For example, virtual reality haptic gloves are currently being used to let the user feel the size, weight, temperature, and impact of virtual objects.[246] Feelreal has

[246] Soper, T. (2017). HaptX reveals high-tech haptic gloves that let you feel and touch in virtual reality. Geekwire. https://www.geekwire.com/2017/haptx-reveals-haptic-gloves-that-let-you-feel-and-touch-in-virtual-reality/. Accessed 4 October 2019.

developed a multisensory virtual reality mask that allows one to experience a limited set of odors.[247] And research is ongoing to develop virtual taste.[248] Bidirectional looped feedback for each mode of perception is necessary for a realistic experience. As we saw with the cochlear implant, the device only functioned well once bidirectional looped feedback between user and device was implemented. The basic idea is that the user is virtually relocated and sensorially immersed, as much as possible, in an artificially created environment and acts within it.

Besides gaming, VRT has been used for rehabilitation of impaired physical and mental function. For example, one experiment used VRT to diminish the intensity or frequency of phantom limb pain. In this research, upper limb amputees wore VRT goggles and a VRT glove on the intact hand. At the same time, small electrodes are placed on the stump. By stimulating the stump with tiny electrical impulses, researchers recreated the sensation of an intact hand. The amputees played a number of different VRT games involving the same activity with both hands such as grabbing a pole that has to be twisted into different shapes or pushing different virtual buttons. In virtual reality, it appeared and felt as if subjects were using both hands. Of three amputee subjects, two experienced ease of phantom limb pain and one experienced diminished frequency of the pain.[249]

According to Bo Geng:

> "The tactile representation of different body parts are arranged in the brain in a sort of map. If the brain no longer receives feedback from an area, it tries [unsuccessfully] to reprogram its signal reception map. That is the most common conception of how phantom limb pain occurs,"

She further theorized that:

> "Even though a person who has had a hand amputated can no longer see it, in many cases he or she can still feel it. This sensory conflict may be interpreted by the brain as pain. With this new method we try to overcome that conflict by providing

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[247] Craig, E. Feelreal- Smell on vr arrives on kickstarter digitalbodies.net. https://www.digitalbodies.net/virtual-reality/feelreal-smell-in-vr-could-finally-arrive/. Accessed 6 April 2019.
[248] Turk, V. (2016). Face electrodes allow you to taste and chew in virtual reality. *New Scientist.* https://www.newscientist.com/article/2111371-face-electrodes-let-you-taste-and-chew-in-virtual-reality/. Accessed 04 October 2019.
[249] Aalborg University. Virtual reality eases phantom limb pain. *Science Daily.* http://www.sciencedaily.com/releases/2017/05/170531102921.html. Accessed 31 May 2017.

> [consistent] artificial visual and tactile feedback and in that way suppress the pain."[250]

The conflict, according to Bo Geng was between seeing and feeling, both cognitive functions. Virtual reality was used to overcome the conflict. Ramachandran used a mirror box to create the same result. He created the appearance, to a subject with an amputated arm who experienced phantom limb pain, that they had an intact arm. Pain, in the case described, was caused by the feeling that the hand was clenched. Utilizing the mirror box, when the subject opened his intact hand and moved the fingers it appeared as though the amputated hand was also doing this. The subject claimed that this eased the pain. Ramachandran's explanation was that the brain sent signals to the stump that the amputated hand was clenched (positive feedback) but, because of the amputation, there was no negative feedback from the stump to 'unclinch' the hand. With the mirror box, negative feedback was provided by the 'illusory' hand (the intact hand as reflected in the mirror) and this was sufficient to alleviate the pain in some instances. The theories in both experiments is virtually the same. Bidirectional looped feedback is necessary to eliminate phantom pain. When the brain is tricked that feedback is coming from the stump by visual data that is in conflict with kinaesthetic data, it attempts to reconcile that conflict. Since visual data takes precedence over sensory data, the reconciliation is accomplished by making the sensory and visual data consistent.

In both instances, the brain is presented with conflicting perceptual data which constitutes noise to be resolved. The brain is weighted toward the attractor of vision normally and since it has a deeper basin then kinesthetic sensation, once visual data is provided, the brain resolves the conflict by reaching a stable state by reconciliation. However, when there is no visual feedback, its basin of attraction is shallow and the basin of attraction of sensation is deep. The result is that the conflict between the two modes of perception is unresolved, and pain persists. The trajectories through phase space can be represented by the two stages: before (reconciling visual data is provided) and after. Before, the trajectory through phase space represents the conflict in data, experienced as ongoing pain. The trajectory veers toward the sensation attractor because its basin of

[250] Ibid.

attraction is deeper (since no visual data is provided). However, after visual data is provided, the trajectory veers toward the attractor of vision because when it is operative, visual perception trumps kinesthetic sensation; the basin of attraction of visual perception is deeper. Bidirectional feedback is a critical element in all complex, dynamic systems, including, of course, the brain.

Immersive virtual reality technology is what VRT is striving toward. Mastery of more sophisticated technology is required to make the VR experience more seamless. And an understanding of the operation and dynamic complex interactions of all bodily senses and systems in interaction with the world will ultimately be required as well. Perhaps most difficult, the phenomenological experience of presence in the virtual environment would also have to be duplicated. While immersion of all senses would seem to be required to accomplish this, it is by no means clear that this would be sufficient. One reason this may be so is that immersion in the actual world involves vast number of combinatorial possibilities of interaction with the world. The problem is resolved by embodiment which limits the number of combinatorial possibilities. Dennett refers to the vast number of combinatorial possibilities of interaction with the world without embodiment as a combinatorial explosion (See section 5.5). Virtual immersion may require the duplication of the physical bodily experience as though the user was actually in the virtual world to avoid the combinatorial explosion.

5.4.1. Dynamic Systems Theory of VRT and IVRT

DST may be used to analyse and explain both the development and the operation of VRT and IVRT. In the development phase, several socio-cultural conditions would be required some of which are: in-depth knowledge of the sciences of perception, brain function and interaction with the world, mastery of the technology needed to create realistic virtual reality experiences, the market and cultural conditions for utilization of the technology and the personnel to drive it forward. Assuming deep basins of attraction of these conditions, a trajectory through phase space would represent the ongoing development of VRT and ultimately, IVRT. If one or more of these conditions is suboptimal as represented by a shallow basin of attraction, the trajectory through phase space, representing the process of development, would be skewed away from that attractor, representing suboptimal developmental conditions.

In terms of the operation of VRT and IVRT when fully developed, parameters include the following: the availability of equipment needed to duplicate all the sense experiences, powerful computers, graphics cards and software to power VRT and IVRT, the market demand for such products and the cultural conditions to support it. Assuming the basins of attraction of all the parameters are sufficiently deep, the trajectory through phase space would represent the ongoing process development, implementation and operation of VRT and IVRT. It is worth noting that there is similarity in the descriptions of the imagined developments of IVRT, the cochlear implants and cardiac pacemakers. In all cases, advancements in scientific and technological advances need to be made and a number of sociocultural events need to coalesce for the ACTs to be realised. The enactivist schema of brain-body-world is played out bidirectionally. For ACTs to be developed there must be a market and once developed the ACTs affect the lives of individuals. And DST can model the development and implementation of ACTs.

As we have seen , DST can analyse and explain several scales---epigenetic, neurophysiological (specifically neural plasticity), interpersonal relationship and environmental context---and the relations between them as numerous examples have now shown. DST may also be used to analyse and explain future development, even those which may seem possible only in the realm of science fiction.

5.5. The Uploaded Mind

The challenge of uploading the mind is the next step after IVRT. Here mind is not merely tricked into virtual reality experience but, in fact, becomes present in and continuous with the experience of its predecessor, the embodied mind. Presumably, from the uploaded mind's introspective perspective, it would be indistinguishable from and therefore identical with its predecessor. In other words, all memories, brain functions, experiences, emotions, knowledge etc would remain intact. If this development was to occur, might it be said that biological evolution has been superseded by technological evolution? And specifically, might technology, rather than biological self-organisation co-organise the mind? Clearly this is speculative, although discussed by many futurists with varying degrees of certainty and enthusiasm. This section and section 5.6 discuss technological developments of this sort.

There are several versions of uploading the min d as Chalmers has discussed.[251] However, for purposes of this discussion, the uploaded mind refers to the wholesale transfer of the functional and phenomenological aspects of the human mind at one time into some non-biological device that meets the broad definition of an ACT. According to this understanding, the uploaded mind would be experientially indistinguishable from the embodied mind. Personality and personal identity would remain intact in the uploaded mind. An important question is whether the structural components would also have to be duplicated. This will be discussed below.

Uploading the mind is discussed by several futurists- Kurzweil[252], Chalmers[253], Bostrom[254] and Tegmark[255] among others. It is an open issue as to the type of entity into which it might be uploaded but presumably the transfer would assure indefinite, temporal continuity with no loss of function or information.

One version of the uploaded mind can be seen as a variation of the thought experiment conducted by Cosmelli and Thompson (2010) in which they essentially argued for the enactive perspective.[256] It references the classic brain-in-a-vat thought experiment. In that paper, they considered what would be required to provide an envatted brain with the exact experience of an embodied human mind. They argued (forcefully in my view) that the envatted brain would need to be provided with exactly all the features of human embodiment (structure and function) and environmental causal input, (including but not limited to information) essentially creating synthetic, embodied human life. According to

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[251] Chalmers, D.(2010). The singularity: A philosophical analysis. *Journal of Consciousness Studies* 17 (9-10). 7-65.
[252] Kurzweil, R. (2005). *The singularity is near: When humans transcend biology* London: Duckworth Overlook.
[253] Chalmers (2010).
[254] Bostrom, N. (2014). *Superintelligence: Paths, dangers, strategies.* Oxford: Oxford U.P.
[255] Tegmark, M. (2017). *Life 3.0: Being human in the age of artificial intelligence.* London: Penguin Books.
[256] Cosmelli, D., and Thompson, E.(2010). Embodiment or envatment? Reflections on the bodily basis of consciousness in Stewart, J., Gapenne, O., and Di Paolo, E. (Eds.). (2010). *Enaction: Toward a new paradigm in cognitive science.* Cambridge, Mass: MIT Press. 361-386.

the enactive view, consciousness is an ongoing process in which brain, body and environmental context are interdependently interacting.

In contrast to the enactive view, the underlying (unrealistic) model of those who envision an uploaded mind is mechanistic and reductionistic. According to this approach, in order to duplicate human experience, all the uploaded mind would have to duplicate is the functions of the brain. For example, Martin[257] mentions that an uploaded mind would have to exactly duplicate the effects of the chemistry of the brain. But if the enactive view of the consciousness is correct, duplicating the brain functions would be necessary but not sufficient. Rather, the uploaded human mind would also have to be placed in a functional and perhaps structural duplicate of the human body and environmental context. According to this view then, the task of uploading the mind would essentially be a component of the larger task of creating artificial life, a much more difficult feat. In the enactive view, the challenge of creating artificial life would intersect with that of the uploading the mind. From what we understand now of neuroscience, genetics, artificial intelligence, information and computer science and biology (to name just a few of the sciences required), the challenge of uploading the mind, let alone the challenge of creating artificial life is formidable indeed.

Dennett implicitly also subscribes to the necessity of embodiment as a practical matter. In his view, physicality constrains otherwise intractable, combinatorial possibilities. He considers a brain in a vat manipulated by evil scientists whose task is to convince the brain that it is experiencing embodied life. Critically, when it comes to kinaesthetic sensing, Dennett concludes that the scientists:

> “Suddenly are faced with a problem that will quickly get out
> of hand, for just how the sand will feel [when lying on a beach] depends on just how you decide to move your finger. The problem of calculating the proper feedback, generating or composing it, and then presenting it to you in real time is going to be computationally intractable on even the fastest computer, and if the evil scientists decide to solve the real-time problem by precalculating and "canning" all the possible responses for playback, they
> will just trade one insoluble problem for another: there are too many
> possibilities to store. In short, our evil scientists will be swamped by

[257] Martin (2006).

combinatorial explosion as soon as they give you any genuine exploratory powers in this imaginary world".[258]

The solution to this dilemma is to limit combinatorial possibilities by physical means. Again Dennett states:

"[T]here is only one way for you to store for ready access that much information about an imaginary world to be explored, and that is to use a real (if tiny or artificial or plaster-of-paris) world to store its own information!"[259]

According to this view, while it might be conceivable in principle to simulate experience of the senses, as a practical matter it could never be implemented. Function alone is insufficient, in itself; structure must also be provided to the uploaded mind to limit the combinatorial possibilities if it is to be realized at all. For the uploaded mind to exactly duplicate the embodied mind, structural embodiment would also have to be exactly duplicated. This is because structure follows function and function dictates structure.

Dennett is correct that combinatorial possibilities need to be limited by embodiment. However, his view that information needs to be stored for ready access may not be correct as it relies on the model of brain as a computer. Embodiment relies upon synapses and neural networks, modified by experience and these operate (in part) with bidirectional feedback to "retrieve" information. As we have seen from the actual experiences of the cochlear implant, neurofeedback devices and Ramachandrin's phantom limb mirror box, embodiment and recursive bi-directional feedback in real time can do what information storage cannot do. Information storage (according to the computer model) may not be necessary, but embodiment is. The uploaded mind would need the identical equivalent of body and brain (both structurally and functionally) as well as environmental context; and the dynamic, complex interactions amongst them. Critically, bi-directional feedback amongst these would be a Self-organised component of this interaction. This is the enactive and dynamic systems perspective.

[258] Dennett, D. (1991). *Consciousness explained.* New York: Back Bay Books. 5.
[259] Ibid.6.

I believe the optimism of futurists certain of uploading the human mind fails to fully recognize the enormity of the task. But theoretically, if this task were to be accomplished, it would certainly occur in several stages, requiring momentous advances in many different sciences and the development of numerous ACTs would be prerequisite. Let us consider a few of the technological and scientific advancements that might be required to upload the mind. For this purpose, let us assume that the mind is uploaded as a replacement for the biological mind. What are a few of the advances that might be required to bring this about? Complete structural and functional maps of the brain (and probably the body) would be necessary. This would require scans detailing structures and functions at all the necessary scales. Furthermore, an exhaustive understanding of the biochemistry of brain and body both reductionistically and dynamically would be required. And if enactivists are correct, complete understanding of the functions and structures of all somatic systems at all scales--- genome and epigenome, nervous systems, immune and endocrine systems, etc.--- and the dynamic interactions of these with environmental and contexts in which brain and body are embedded would be necessary. Again, digitizing neural and functional information and structural detail would be another task, requiring the collaboration of computer and information scientists, neuroscientists, geneticists, and biochemists among others. Also, a supportive cultural milieu would be necessary to encourage these developments. Benefits deriving from these advances would need to align with cultural normative values, for example, increased individual health, vitality, life extension and quality of life. Otherwise there would be no market for the upload and finances and personnel resources would not be available to create the necessary advances. Assuming all such parameters had sufficiently deep basins of attraction, the process of development and implementation of the uploaded mind would be represented by a trajectory through phase space. A point on the trajectory would represent the state of all control parameters at a moment in time.

These considerations point to the multiscale, complex, dynamic nature of the task of uploading the mind and perhaps the practical impossibility of the task.. In principle, dynamic systems theory provides the concepts and tools to analyse the multiple interdependences of mind, all somatic systems, cognitive technology, and cultural context (including interpersonal relationship).

As the scale of interdependence between mind and other factors-genome, brain, interpersonal relationship and social and technological context- outwardly expands, the interaction amongst all these factors creates increasing complexity. Projecting into the future creates an additional level of complexity but considered as a thought experiment, this is merely a barrier, not a bar. While in principle, dynamical systems theory could apply, in practice, even if the uploading of the mind is eventually accomplished, the description in dynamic systems terms from lower level phenomena would take immense computational resources. Again, not a bar.

Recall that aside from showing the applicability of DST, another goal of this chapter was to argue that with the development and implementation of various ACTs and the advances of multiple scientific disciplines in the future, in principle, humans conceivably could develop the capacity actively to participate in the evolution and organization of the mind and more generally, of life itself, to a greater extent than ever before. In that event, human intervention for the first time would become an even more radically transformative perturbation in the organization, establishment and maintenance of mind. The cases of the uploaded mind and negligible senescence which will discussed next make this point.

The uploaded mind presents many philosophical and moral issues, the mind-body problem and personal identity being particularly prominent.

One that is particularly relevant to this dissertation is the question of whether the uploaded mind would be conscious and if so, what would be its characteristics. The resolution to this question presents the possibility of affirming either the enactive view, according to which mind is constituted by brain, body and environment, or the neural-reductionist view, according to which mind is constituted by brain function alone.

Both agree that consciousness emerges from complexity, but they disagree on the nature of that complexity. The view of many neuroscientists is that if human neural information and function were accurately digitised and successfully uploaded *in toto*, then there would be sufficient complexity for human consciousness to arise, for consciousness is only a brain function. In this view, the digitized bits are both necessary and sufficient for human consciousness. Martin says:

> "Would a silicon version of the human brain be conscious? Possibly yes. It is a popular view at MIT that when machines have sufficient complexity they will acquire consciousness".[260]

In my view, such an analysis is not sufficiently fine grained as it fails to characterise the nature of the transferred consciousness. The unstated assumption seems to be that the uploaded consciousness would be human in nature but that is not the only possibility. Enactivists would disagree with such a reductionistic assessment. In their view, since human consciousness requires the interdependence of brain, body and environmental input, consciousness would not emerge merely from uploaded neural complexity. If enactivists are correct in their understanding of the necessary and sufficient conditions for the emergence of human consciousness, then the uploaded silicon version would also need to digitize the structural and functional equivalent of the human body, the functional (and perhaps structural) relationships between all the relevant components and systems at all scales and the functional equivalent of environmental context. Otherwise the upload might be a new but nonhuman form of consciousness, if it could be termed consciousness at all.

According to one view, the purpose of uploading the mind as a replacement for the biological mind would be to create an immortal identical Self, the technological equivalent of the long-sought fountain of youth. The unstated assumption is that the uploaded intact mind would be identical to the embodied mind but in virtue of its new embodiment could outlast the biological body's death. However, uploading the mind is not the only way to achieve a version of the "immortal Self. Another approach is to devise the means to repair or replace somatic structure and function at the cellular level so that in essence, one retains vibrant physical and mental function, health and vitality indefinitely. This approach, described below, is referred to as "negligible senescence" and is the subject of current research.

[260] Martin (2006). 216.

5.6. Negligible Senescence: Age Related Deterioration as a Disease which may be Alleviated

If death itself cannot be conquered (an assumption I will examine in the next two chapters) then the next best thing ('best' is an assumption I will not examine) might be eliminating age-related functional and structural deterioration (brain and body) in all its manifestations. The consequence would be that one's mind and body would remain vibrant and healthy as long as one lived, and one would not die due to age-related diseases or deterioration. One might then have a healthy, indeterminately long lifespan. Negligible senescence might (or might not) require more than simply eliminating the causes of age-related deterioration. It might also require scientists to intervene to re-organize structures and processes at multiple scales---genetic, biological, physiological, biochemical, etc. If artefactual technology made this possible, humanity perhaps would co-organize life (human or otherwise) as never before. Our understanding of autopoiesis might then be significantly revised, supplemented or perhaps even become anachronistic.

De Grey has taken a position contrary to the most widely held view as to the inevitability of age-related deterioration and death. He states his view dramatically: senescence is a disease that may be cured. Senescence refers to biological aging and the resulting deterioration of biological structures and functions. Negligible senescence does not imply immortality. As a geneticist, he has taken on the task of identifying those biological features which constitute senescence and he believes that each of the features he has identified can be alleviated and even reversed. De Grey focuses his research in the areas of genetics and molecular and cellular biology. Yet if negligible senescence is ever to be achieved, significant future contributions from computer and information sciences, neuroscience, molecular biology, genetics and nanoscience among others will certainly be required.

De Grey's claim is not as far-fetched as it might seem. While most living things suffer senescence, there are some creatures that don't- lobsters, hydra and plantarian flatworms. And while most human cells inevitably suffer senescence, tumour cells do not. Cellular senescence refers to the failure of cells to divide. Leonard Hayflick discovered that *in vitro* cultured cells divided no more than 50 times- the Hayflick limit. However, this is not the case with tumour cells, stem cells and germ cells which are, somewhat misleadingly, said to be immortal. That is, they are not subject to the Hayflick limit. So, one line of inquiry is to investigate why lobsters and the like do not suffer senescence. And a second line of inquiry is to investigate how tumour cells, stem cells and germ cells relevantly differ from other cells. One relevant difference is that these types of cell are not subject to the Hayflick limit.

Each time a cell divides the telomere, a 'cap' on both ends of the chromosome, shortens. The telomere is believed to be related to the longevity of the cell and its ability to divide. Each time cells divide, a process referred to as mitosis, the telomeres shorten and after many divisions, cells do not have sufficient telomere length to continue to divide. When such cells cease to divide; they are senescent. However, these cells remain metabolically active and produce waste products that accumulate. The body rids itself of some but not all senescent cells and the accumulation of these cells together with their waste products are thought to contribute, in part, to aging, disease and eventually to death. The enzyme telomerase is understood to maintain telomere length by adding DNA code as necessary, thereby extending the life of the cell. It is believed that the reason tumour cells, stem cells and germ cells do not suffer senescence is due, in part, to their production of the enzyme telomerase. And it has been demonstrated that human somatic cells normally subject to the Hayflick limit continue to divide beyond this limit when treated with telomerase.[261]

De Grey's focus in life extension has been to identify and ideally eliminate the causes of senescence at least at the genomic, cellular and biochemical scales. His approach may be broadly described as repairing or ideally reversing the damage caused by metabolism before the accumulated damage becomes toxic. One focus of the research performed and/or funded by De Grey's SENS Research Foundation is stopping the proliferation of cancer by stopping cancer cells from maintaining telomere length. SENS stands for "Strategies for Engineered Negligible Senescence. As the name implies, whether accomplished by drugs or other means, the approach utilises the application of cutting-edge artefactual technology.

[261] Petersen, T. and Niklasen, L. (2007). Cellular lifespan and regenerative medicine. *Biomaterials* 28:26. 3751-3756. Telomerase has been used to extend the cellular life of tissue that may then be used for skin grafts. However, this technique is not risk free as cellular mutations increase beyond the Hayflick limit.

For example, one approach is the use of senolytic drugs and dietary supplements, to reduce the quantity of senescent cells in the body.

Lest one think that only artefactual technologies are effective in retaining telomere length and thereby contributing to longevity, it has been shown that certain healthy lifestyle practices, such as stress reduction techniques, positive mental attitude, resilient thinking, cardiovascular exercise and certain phenomenological technologies such as mindfulness practice and meditation have also been effective. Conversely, stressful lifestyles and mental attitudes shorten telomere length.[262] In the next chapter, phenomenological technologies, which might be used to achieve diminished senescence, will be discussed in detail and I will touch on effects on mind and body.

5.7. Concluding Remarks: Might Technology Co-Organise the Mind?

Recall that the brain has a viable domain within which it operates. Perturbations do not determine its structure. Rather, the brain adapts within its viable domain to those perturbations and artefactual cognitive technology is a perturbation to which it must adapt. One of the mechanisms of adaptation is neuroplasticity. The brain may change its structure and function in relation to technologies that are used as significant appendages to everyday life (such as the smartphone). Such ACTs may be said to be structurally coupled with humans. This coupling is dynamic, complex and recursive. And there is a feedback loop between technology and humans such that they co-evolve.

One question I have raised in the beginning of this chapter is whether technological self-organization might supplant biological autopoiesis. There is an answer to this question which is trivial; that is, since the human organism (brain and all systems) has a domain of allowed viability, technological self-organization cannot supplant it without changing the identity of the person. But this raises the question as to what constitutes the identity of the person. This question becomes nontrivial in the case of the uploaded mind. How does one determine whether the uploaded mind is identical to the embodied mind?

[262] Blackburn, E. and Epel, E. (2017). *The telomere effect.* London: Orion Publishing Company.

There is another situation in which technological self-organization could be said to supplant biological self-organisation (of the brain): This is the situation in which technology, either artefactual or phenomenological, exercises significant control over the process of dying and death. In the case of phenomenological technology, one question is whether this ability is within the capacity of the organism or whether the capacity has emerged as a result of a complex, dynamic process such as meditation. In the next chapter, I consider Indo-Tibetan Buddhism which claims that one can train the mind to exert some control over the experience of death. In chapter 7, I compare western ACTs and Indo-Tibetan Buddhist PCTs as relates to death and dying.

Chapter 6

Indo-Tibetan Buddhism: A Case Study in the Eco-Dynamic Paradigm

"Out of ignorance, we tend to relate only to our personal experience… These sense perceptions confirm the ego. We tend to think that everything revolves around our sense perceptions and understanding and anything beyond them cannot exist…So world systems must be appreciated in their entirety."[263]

6.0. Introduction

In this chapter, I describe how several philosophical concepts, doctrines, analytical tools, and phenomenological practices of Indo-Tibetan Buddhism[264] (Theravada, Mahayana and Vajrayana traditions collectively referred to as ITB) interdependently and recursively relate to contribute to a unique understanding of mind. The quote above encapsulates several concepts that are integral to the ITB world view. This chapter expounds on this world view and on some key concepts. In general, the quote refers to the limited perspective with which humans tend to see the world. This parochial frame of reference is referred to as "ignorance" in Buddhist parlance but the scope of ignorance is vast, incorporating behaviours, thoughts, intentions, unconscious dispositions, linguistic structures and social conventions. It encompasses the misconceived reliance on sense perceptions and experience to circumscribe the scope of reality. And the solution is a wider framework which appreciates world systems. "World systems" is meant broadly to include a vastly expansive view of ITB ontology, epistemology and ethics. And the reference to "systems" signals that many of these concepts are interrelated, interdependent, synergistic and recursive. As such, ITB may be conceived as analogous to an ecology in which the

[263] Khandro Rinpoche (2005). *This precious life*. Boston: Shambala. 38

[264] Vajrayana or Tibetan Buddhism has absorbed much of the doctrine and practices of Theravada And Mahayana Buddhism. When I refer to Indo-Tibetan Buddhism I am making reference to this expansive Vajrayana. However, there are some instances in which Vajrayana departs from Theravada and Mahayana since the former contains esoteric practices and doctrine whereas the latter contains only exoteric practices and doctrine. Since this dissertation is not concerned with the fine points of Buddhism except to compare and contrast some features for the purpose of elucidating the eco-dynamic paradigm, I refer only to Indo-Tibetan Buddhism.

components individually sustain and synergistically reinforce each other to create a system greater than the sum of their parts. Thus, I will be discussing the systems perspective from two senses: as *modus operandi* within ITB and externally, from the dynamic systems perspective, as a means of describing ITB dynamics. ITB practices and teachings are dynamically oriented and prescribed to alter the cognitive framework of practitioners.

The tools of dynamic systems theory (DST) can, in principal, be utilized to analyse and describe these interdependences. Previously I have asserted that the tools of DST may be utilized to analyse the dynamics of epigenetics, neurophysiology, interpersonal relationship and technology. Now I assert that in the same manner, these tools may also be used to describe the interdependencies of various ITB practices and concepts. ITB concepts[265] and practices are process driven, coupled, interdependent, and recursive. These are among the features that make them amenable to DST analysis. For example, each of the elements of the Eightfold Path (section 6.1.4 and section 6.2 below) are attractors all of which are coupled. And some elements (e.g. mindfulness) provide a mechanism for recursivity and the nudging of the trajectory of practitioners toward the attractor of wisdom and away from the attractor of ignorance. All these elements are in turn coupled with practices and teachings involving 'selflessness'(no-Self), a strong attractor (see 6.5 below). Again, selflessness practices are coupled and interrelated with the twelve links of Dependent Origination (see 6.3 below). Certain elements of these practices and teachings are stronger attractors with deeper basins but none are independent. It is also true that certain concepts and practices of Buddhism are understood by Buddhists themselves to be dynamic, interdependent, time sensitive and recursive. The most obvious example is mindfulness, specifically that portion we refer to as metacognition, awareness of one's mental processing. Metacognition or Self-reflexivity allows one to observe one's behaviour, speech and thoughts 'from a distance' as it were and determine whether or not such is *dharmic*.[266] Practitioners use metacognition both in meditation and every aspect of life to observe their modes of being in the world and to identify those that constitute cognitive obscurations. These are sometimes described as the three poisons: ignorance, hatred and attachment.

[265] In general, Buddhist concepts are meant to be integrated into practices. They are pragmatic and phenomenologically realized, not merely theoretical.

[266] The word d*harma* (Sanskrit) has several meanings. Here it refers to activities that are conducive to clearing cognitive obscurations. In other contexts, the term may refer the teachings of the Buddha.

These are umbrella terms each describing a raft of ways in which humans mistakenly narrow their perspective on reality. Importantly, metacognition is used to deconstruct the mistaken construct of the Self.

The Mahayana Buddhist doctrine of 'two truths' (section 6.7 below) bears a similarity to Kelso's view of complementarity. Each similarly posits that seeming polar opposite concepts (such as appearance and reality)[267] may in fact be complementary. For instance, from the ITB perspective, there are complementary senses in which the Self may be said simultaneously to exist (in a conventional and nominal sense) but not exist (inherently or ultimately). Similarly, Kelso holds that Self and other are not contrary but rather are a complementary pair.[268]

In chapter three, neuroplasticity has featured prominently. Critical to this mechanism is the element of recursion where neural structure and function is modified as a result of looped iterations. Likewise, the plasticity of mind is the foundational basis upon which all ITB practices and doctrines depend. Suffering[269] (skt.*duhkha)* is considered an impermanent but primordial cognitive condition arising from ignorance of the nature of Self and reality which can be ameliorated by study, logical reasoning, various meditative practices, rituals, prayers and transformative realizations.[270] It is believed that many factors contribute to one's cognitive imprisonment and these interact to reinforce one's suffering. But there are antidotes which can be skilfully utilized to release these bonds. ITB phenomenological cognitive technologies (PCTs see section 5.2) are the way forward. It is claimed that, in part, by examining one's experience and mental content, observing cognitive obscurations (from the *dharmic* perspective) through metacognition, correcting faulty views and following the suggestions and practices of those who have been successful in the past, one can become free of suffering. This freedom is referred to as liberation, enlightenment or *nirvana* (Skt). The practitioner is advised to critically examine and experience various types of meditation, other practices and doctrine to determine for oneself whether these bear fruit. *A priori*

[267] In the history of western philosophy, Bertrand Russell wrote on the distinction between appearance and reality. Briefly, appearance was provided by sense perception. Reality was revealed by science.
[268] Kelso, J.A.S. and Engstrom, D. (2006). *The complementary nature.* Cambridge Mass: MIT Press
[269] See 6.2.1 below for a discussion of this term.
[270] According to ITB, the term "realization" is distinguished from understanding. It engenders a profound phenomenological experience with a cognitive element that transforms the way life is lived. The experience bears a similarity to eureka effect but is different as well.

faith is discouraged except insofar as to allow for critical examination. Clearly, there is a strong empirical element in the ITB tradition.

However, it is implicit that while PCTs are necessary to eliminate cognitive obscurations, they are not, in themselves, sufficient. Experience deriving from such technologies must be interpreted, thus placed in a contextual framework within which they must be understood. In essence, the mind must be used to clear the mind. This is an experiential bootstrapping process in which the whole ITB framework--- learning, analysis, PCTs, etc---operates dynamically and recursively to "lift the veil of ignorance". Paradoxically, while the whole ITB conceptual and technological framework must be employed and thus taken seriously, there is, at the same time, an understanding that these devices, while epistemically useful, are not substantial; useful tools which must eventually be jettisoned. Any framework at all is understood to be a constrained perspective on reality. There are two truths at play (section 6.7 below). The ITB framework is conventionally useful but not real in the 'deepest' sense; it is merely a methodological tool to overcome ignorance but abandoned when it no longer serves that purpose. Thus, the goal is to grow beyond the structural constraints of ITB methodology to realise emptiness; not just the emptiness of the ITB framework but the emptiness of all phenomena; nominally real but not inherently real. What is inherently real is said to be beyond language and conception, but paradoxically, is often described by referring to the insubstantiality, interdependence and unitary nature of all phenomena.

There is concurrence with ITBT and enactivism in several regards, among these are the belief that perceptual and cognitive faculties together with environmental factors (mind-body-environment) co-create experience. And both find the analytic method, whether conceived as scientific method or phenomenological and linguistic analysis, useful in understanding the nature of the mind. But the analytic method of each is different.

They depart in one significant aspect which presents a challenge for enactivism. Indo-Tibetan Buddhists claim that the deepest nature of mind (Tibetan *rigpa*) is very subtle and immaterial; it survives the death of the physical body. The claim is that if one is successful in stabilizing mind in its natural (enlightened) state, pure awareness free of concept or duality, one can remain conscious throughout the process of dying and into death. This belief separates ITB from physically/biologically based philosophies which either don't consider this possibility (enactivism) or would deny it altogether (physicalism). The eco-dynamic paradigm which I am developing (Chapter 8) would not *prima facie* dismiss such

ITB claims but rather would take them either as discordant or "complementary" data (in the Kelso sense) and therefore worthy of further consideration and study. It is intriguing that many witnesses who have observed the dying/death process of so called "realized Buddhist masters" over millennia have attested to various apparently scientifically inexplicable (to date) phenomena. For example, the heart region of such a person has allegedly remained warm for an extended period of time--- 3 days or more--- after death of the physical body and physical deterioration does not occur during this period. The eco-dynamic paradigm that I am developing takes these claims seriously to the extent that they may demonstrate features of mind and body not presently known to science. While this paradigm does not readily depart from the naturalistic stance, it is sufficiently open-minded to examine such phenomena and discover if there may be facts which challenge naturalism as currently understood.

Finally, the Buddhist doctrine of no-Self (Skt. *nātman* section 6.6 below) finds resonance in naturalistic and physicalist philosophies. ITB provides skilful means to experience and develop selflessness thus loosening and eventually releasing the three poisons. It is claimed that selflessness is a skill which may be cultivated. ITB utilizes the experience of selflessness to draw conclusions about the nature of reality consistent with this experience. The realization of one's interdependence with others and with the world as a whole is not only intellectualized. Many physicalist and naturalist philosophies also conclude there is no central control feature (homunculus) that directs consciousness and awareness but there is no framework within which to apply this recognition within modern contemporary society. The paradoxical result is that while the Self cannot be found, one lives as though it does exist inherently.

In what follows, I will describe the following ITB doctrines and practices which constitute an important fragment of its conceptual framework: the Four Noble Truths, the Eightfold Path, The Three Jewels, no-Self, impermanence, dependent co-origination, two truths, various meditation practices and beliefs and practices related to dying and death. I will demonstrate the application of dynamic systems theory by example.

At the outset, it is necessary to recognize that ITB has always been a dynamic religio-philosophical set of beliefs, doctrines and practices. It has incorporated aspects of *Theravada* and *Mahayana* Buddhism as well as aspects of the indigenous Tibetan *Bon* shamanic tradition. Not only did ITB integrate earlier teachings and evolve as it moved from country to country but it also has evolved from the early pragmatic teachings of the *Buddha* to the metaphysical doctrines and commentaries of later *Mahayana* and *Vajrayana* Buddhism. And more recently as it has migrated to the West, ITB has evolved to suit the contemporary mindset of Westerners. In his forthcoming book, Thompson refers to this as "modernist Buddhism". Since the purpose of this chapter is not to be true to a particular interpretation of ITB but rather to use its concepts to illuminate the eco-dynamic paradigm of mind and vice-versa, I will draw on interpretations across the spectrum of Buddhism.

According to some *Theravada* Buddhist thinkers (*Theravadins*) the essentials of *Gautama Shakyamuni's* teachings can be summed up briefly by two principles, The Four Noble Truths and The Eightfold Path.[271] Accordingly, I will describe these doctrines in some detail.

6.1. The Four Noble Truths

The plastic nature of mind is the central premise of the Four Noble Truths. When the *Buddha* declared that mind was the source of all suffering but that suffering was not permanent or inevitable, he created the foundation for perhaps the first 'eco-dynamic' systems conception of the mind. The mind can be trained. Various phenomenological cognitive technologies and social structures were devised, in part, to hone and alter awareness, attention, emotion, perception and consciousness and to reconfigure one's conceptual and existential framework. After his enlightenment, in his first oration, the *Buddha* is said to have turned the first wheel of *dharma.* He stated what has come to be known as the Four Noble Truths. The first truth: Life is suffering/painful; the second: there is a cause for this suffering; the third: there is a solution, a pathway through suffering; the fourth: that way is the Eightfold Path. The first two truths deal with the cause of suffering, the last two deal with its resolution.

In Chapter 3, I discussed neuroplasticity from the scientific perspective. According to that understanding, plasticity arises from the nature of the brain, the source of all cognitive function (notwithstanding the somatic and environmental contribution). Brain function is plastic because brain structure is correspondingly plastic. ITB too recognizes the plasticity of

[271] Bhikkhu Bodhi (1994). *The noble eightfold path: The way to the end of suffering*. Kandy, Sri Lanka: Buddhist Publication Society.

mind but there the similarity ends. Buddhism's concern is soteriological whereas the concern of neuroscience is secular. And unlike neuroscience, ITB does not hold the brain to be the ultimate source of cognitive function. However, these differences should not dissuade one from seeing the value of the ITB perspective. ITB PCTs have apparently produced results which hold the potential to expand the neuroscientific understanding of mental function and mind-body interdependence. Therefore, it is the approach of the eco-dynamic paradigm to investigate ITB PTs nonreductionistically and the reported results they have produced in some practitioners. This requires an alteration in the standard scientific methodology in a number of regards. For example, reproducibility of results is a golden standard of the method. However, given the arcane and rare nature of the phenomena under investigation, reproducibility is difficult. Again, large population samplings are standardly required. However, in the case of advanced PCTs, the number of individuals who can be tested is necessarily small. And also, the need to understand the results of brain scanning technology requires the incorporation of first-person data but neuro-phenomenology, a methodology which employs the correlation of first and third person data, is viewed with some suspicion by the neuroscientific community. Finally, the naturalistic foundation of scientific methodology, with its (attempted) rejection of mind-body dualism, presents problems as discussed in chapter one. Mind-body dualism has gained such a foothold in society as incorporated in the language and concepts commonly used that, even many physicalists, on the one hand, deny mind-body dualism but on the other hand, unconsciously affirm it. For example, when the cause of a physical illness cannot be identified it is sometimes said to arise from causes "all in one's head" meaning imagined and not therefore real.

6.1.1. First Noble Truth

In the words of *Buddha*: "Birth is suffering; Aging is suffering; Death is suffering; Sorrow, lamentation pain, grief and despair are suffering; not to get what one desires is suffering…"[272]

[272] Nyanatiloka (date unknown). The word of the Buddha. Kandy, Ceylon: Buddhist Publication. 20-21.

The traditional translation of the term *'duhkha'* is suffering which I will use hereafter. However, a more modern translation is "dissatisfaction".[273] This gives a psychological and more expansive turn and I believe more accurately encapsulates what the Buddha thought, since it has an existential connotation. The term applies to something deeper than pain. It applies to an existential dissatisfaction underpinning our lives, a basic feeling that life doesn't seem quite right because it does not provide ultimate satisfaction. This may be conscious or it may be quite subtle, a vague sense of disquiet that life is not what it should or could be. Of course, stronger feelings of grief, despair or disappointment may also manifest as suffering.

In modern parlance, suffering is caused by conceiving and experiencing life with a cognitive bias, desiring life to be other than it is, an admixture of pleasure and pain, all experience and phenomena existing impermanently and transitorily. As this is a deeply ingrained cognitive problem its resolution is also cognitive. Recognizing the nature of the problem begins to correct it but is not in itself sufficient, for this problem is not merely intellectual. It is also existential. Humans are predisposed to seeking and clinging to pleasure (attachment) while avoiding displeasure (aversion). But since these are inherent in life, both attachment and aversion are futile.[274] And more deeply, humans are predisposed to misconceiving the nature of the subject of pain and pleasure as an abiding, permanent Self. The senses and experience inform this misconception because they are isolated in a physical structure (the body) which appears to persist through time. It is not the case that one merely needs to change one's thinking about the nature of the Self. Rather, the shift from Self to recognition of no-Self is both cognitive and phenomenological. One needs to experience the Self as interdependent, impermanent and contingently existing. And also one needs to experience the dissatisfaction of the misconceived Self in one's gut (so to speak); that is to say, the existential experience must be transformative.

The *Buddha* recognized through his own experience that suffering had an internal cause and that one could eliminate the cause by creating this transformative shift. He accomplished this, in part, through the experiences that arise through the practices of

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[273] Wallace, A. (2012*). Meditations of a Buddhist sceptic: A manifesto for the mind sciences and contemplative practice.* New York: Columbia U.P.

[274] In this regard, ITB bears a resemblance to Stoicism. ITB analyses the desire to seek pleasure and avoid pain and concludes that this tendency can be a source of suffering. Therefore, it provides practices to overcome this tendency.

meditation. Thus, meditation along with other PCTs became fundamental to the development of ITB. These will be discussed in detail below.

The ITB notion of suffering flies in the face of the post-industrial consumerist understanding of suffering. According to the latter view, (which granted, is not held by a fair few) suffering is caused by a gap between what one desires and what one possesses. Often (but certainly not always) the gap is materialistic and the putative resolution is to obtain the things desired. Since the desiderata are outside oneself, one is not required to search for the causes of dissatisfaction within. On the other hand, the ITB notion of suffering is that it arises due to the investment in the misconceived belief in a permanently existing Self and independently existing phenomena. Since the cause of ignorance is not outside oneself, it may be resolved cognitively.

6.1.2. Second Noble Truth

According to the *Buddha*, craving, grasping and attachment arise from ignorance. Sensual craving for example, arises as a result of the desire for sensual pleasures. Due to desire for such experience and for its continuation, one craves the means of attaining pleasure and one clings to it. Likewise, one is averse to that which is unpleasant or causes suffering. But craving and attachment apply not only to physical things but to a wide variety of phenomena and experiences which in turn lead to a causal chain of events resulting in suffering. Suffering is then perpetuated by remaining within the causal chain known as Dependent Origination.

Attachment and craving as the cause of suffering is well illustrated by the following traditional Buddhist story. A woman lost her child due to illness and carried the body of the dead child to the *Buddha*. She requested that he heal the child, bring him back to life. The *Buddha* agreed to do this but first set a precondition. He required her first to bring a mustard seed to him from the house of any person who was not personally touched by death or suffering. The woman diligently went about to all the houses in the community but could not find anyone who was not so inflicted. She then realized that loss and suffering were part of life. To try to avoid these experiences was futile. She returned to the *Buddha* who gave a discourse on attachment and grasping. According to the story she then became a student of the *Buddha*.

This story rankles the mind and rightly so. It might seem that the *Buddha's* prescription is to not become attached to one's children and this interpretation is indeed harsh. I believe that the better interpretation is that the *Buddha* was pointing out the impermanence of all life, in fact all phenomena. Therefore, one should not expect or hope that the inevitability of death would not occur in their own or their loved one's case.

It is important to note that, from the ITB perspective, the causes of suffering must be pinpointed before suffering may be eliminated. Only when these are identified may antidotes be found to remedy suffering. It might not be overstating to assert the centrality of causality to Buddhism. This causality is complex and so the nature of causality too must be recognized as complex and dealt with holistically; dynamic, context dependent, multicausal, cognitive and somatic, recursive, etc. The doctrine of Dependent Origination serves this purpose.

Craving, grasping and attachment constitute an inseparable triumvirate. Craving implies more than mundane desire. It connotes unquenchable desire that unceasingly grasps. Grasping implies more than the mere seeking the desiderata. It implies a constant rapaciousness and what's more, locates and isolates the subject, the individuated Self that seeks the object of the benefit. Attachment references the desire to cling to that which is impermanent, thus affirming the existence of a continuous, inherent Self that repeatedly seeks the object of desire. The problem with craving, grasping and attachment is twofold: first, one seeks permanently to retain that which is inherently impermanent and secondly, subject and object are individuated, and both are conceived as continuously existing and independent. One then seeks their own benefit without due regard for the impact on others. According to ITB, this false conception of Self violates reality in that the Self and all things exist interdependently. Similarly, interdependence is crucial to DST.

Craving, grasping, and attachment are strongly coupled with and perpetuate the individuated notion of Self. And this mistaken notion of Self in turn perpetuates craving, grasping and attachment. Thus, features of ignorance create a bidirectional or circular recursive loop which, from the ITB perspective, keeps one within the cycle of ignorance.

From the perspective of DST, craving, grasping, and attachment are attractors with deep basins. Likewise, all the prescribed practices and teachings are attractors designed to make less deep the basins of attraction of craving, grasping, and attachment and thereby affect the trajectory through phase space of the practitioner. A point on the trajectory represents the cognitive state of the practitioner at a moment in time.

From the enactive perspective, these same features of ignorance demonstrate the interdependence of mind-body-world. In the story related above, the suffering of the woman was connected to the mistaken belief that she was the only one to suffer loss. The realization that loss was a universal phenomenon brought clarity to her situation (but presumably did not alleviate her pain[275]).

6.1.3. Third Noble Truth

Since the cause of suffering is cognitive and existential, the means to its cessation must be deeply experiential, not merely intellectual. One must cut the root of craving, grasping and attachment by a profound realization of the futility of these cognitive modes, which ultimately arise from the belief in the existence of a continuous, permanent, independent Self. The manner of achieving this goal is through a disciplined regime, the Eightfold Path (section 6.2.4 Fourth Noble Truth).

The assertion of an eternal, independent Self (Skt. *ātman*) was a fundamental precept of Hinduism, the predominant religion of India at the time of the Buddha. The Buddha dissected the conception of Self analytically to dispose of the conception of an eternal, independent Self. He said that Self is composed of five parts which he referred to as 'heaps' or 'aggregates' (skt. skandhas). These are: 1) form, matter or body (*rūpa*), 2) sensations or feelings, (*vedanā*), 3) perceptions (*samjñā*), 4) mental activity or formations (*sankhāra*), and 5) consciousness (*vijñāna*). Each skandha exists dependent on specific causes and conditions. Thus, according to ITB, the core concept of the Self exists conventionally, as a linguistic designation, pragmatically useful to designate an agent operating in the world but substantially or inherently empty. The analysis was further confirmed by observation of one's moment to moment mindful experience in meditation and life, which revealed the transitory nature of each of the *skandhas.*

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[275] One should distinguish between pain and suffering. Suffering arises from ignorance; dissonance between what one wants and what one gets. Pain, on the other hand, is a somatic or emotional response, which is independent of ignorance.

In the language of DST, each of the five skandhas is a dynamically unstable control parameter. These interdependent *skandhas* give rise to a trajectory in phase space which constitutes the changing *skandha* status of the psycho-physical person. A point on the trajectory represents the balance of the *skandhas*, that is, the state of the psycho-physical person, at a moment in time.

6.1.4. Fourth Noble Truth (The Eightfold Path)

Reflecting on his own experience perhaps, the *Buddha* stated that the Eightfold Path was the means to cessation of craving, grasping and attachment and resulted in liberation from the cycle of ignorance. This Path, originally meant for monks and nuns, consisted of practicing eight elements: right view, right aspiration, right speech, right action, right livelihood, right effort, right mindfulness, right concentration. These eight elements are interdependent. For example, right speech requires mindfulness, recognition of the consequences of idle speech (right view, right action) etc.

The use of the term “right” in the ITB context was given a pragmatic cast. I think that “efficacious” gives a more accurate picture of what was intended. And the use of the term “ethics” may cause confusion if one conceives of the term from a Western perspective. There is no standard upon which to judge what is right apart from its impact in advancing one’s liberation. While this bears similarity to a consequentialist view, there is a difference. From the ITB perspective, what is considered “right” and “ethical” is tied to what has been successful in the past. The *dharma* gives guidance in this regard so one is constrained in interpretation and action.

6.2. The Eightfold Path

6.2.1. Right View

This consists of an understanding of the Four Noble Truths, the fact of suffering, its causes and its elimination; the understanding that actions have consequences in life and even after death.[276] In the *Māhāyana* and *Vajrayāna* framework, right view was embodied in the ideal of the *bodhisattva*, the aspirant who sought enlightenment so that he could help all sentient beings eliminate suffering. Right view also includes the understanding of impermanence and interdependence of all phenomena.

6.2.2. Right Aspiration

Right aspiration was originally understood as requiring the adoption of the lifestyle of a wandering mendicant who begged for food. The practice was thought to aid in contemplation of loving kindness, impermanence, suffering, and no-Self. Right aspiration was later broadened in the *Māhāyana* framework to motivate the aspirant to seek the ultimate liberation of all sentient beings.

6.2.3. Right Speech

Right speech was originally understood as refraining from lying, rude speech and gossiping. It was later broadened to require one to speak only with the goal of achieving liberation, thus furthering right view, right aspiration, right conduct, etc., interdependent variables in a complex system.

[276] The Sanskrit term *karma* translates literally as action and refers to one's occasional and habitual actions, the consequences of these actions, and the psychological tendency to repetitively engage in the same type of action.

6.2.4. Right Conduct

Right conduct originally referred to the avoidance of killing, injuring, stealing, and sexual acts as these impede liberation and have negative consequences for others as well. Later it was broadened to include actions and thoughts which benefitted others and to exclude actions and thoughts that caused suffering to oneself and others.

6.2.5. Right Livelihood

Right livelihood was originally understood to require one to beg for one's food and possess only what is essential to sustain life. It fostered non-attachment and recognition of one's interdependence because the monk relied on others to survive. Later the concept was broadened to designate work which benefited sentient beings.

6.2.6 Right Effort

Right effort referred to guarding against "negative" thoughts and actions and focusing on thoughts and actions conducive to liberation. Negative thoughts and actions were designated as those which strengthen destructive emotions which fuelled craving, attachment and grasping.

6.2.7. Right Mindfulness

Right mindfulness requires one to be aware of what one is thinking, saying, and doing. Together with right view, right effort, right conduct (once again interdependent variables in a complex system), right mindfulness is essential mind training which undermines the belief in the independent Self and strengthens one's ability to adhere to the other elements of the Path. Metacognition is often taken for granted but seldom explicitly mentioned in regard to right mindfulness. It requires one to be continually aware of their mental content and their intentions for their actions. It is required not only for mindfulness but for all PCTs as it enables recursion and reflection. Practitioners need to note when thoughts and actions deviate from *dharma* and make appropriate corrections. Without the element of metacognition all practices would come to naught.

6.2.8. Right Concentration

Right concentration involves the practice of four stages of meditation[277] which culminate in liberation. Each of the four stages designate the practitioner's accomplishments. In turn, right concentration feeds back to strengthen right view, right effort, right mindfulness, etc.

These eight are often grouped as follows; the first two are about wisdom, the next three are about ethics and the final three are about meditative practice.

The Four Noble Truths are validated by the Eightfold Path and conversely, the Eightfold Path is implicit in the Four Noble Truths. Because the two are inter-embedded and coupled, there is recursive interdependence wherein practice of the Eightfold Path leads to the demonstration of the value of the Four Noble Truths which leads to further practice.

One might think that the eightfold practices are independent or hierarchical but this is not so. In practice, all eight are interdependent and are to be practiced concurrently. Causality with regard to the Eightfold Path is not linear but rather complex, multifactorial, situational and coupled, so that negligence in the practice one or more of the eight might lead to failure to achieve the desired result. The metaphor of "path" might perhaps be misleading as it implies linearity.[278] The intent might be better understood if the term "method" was used. In systems terms, each of the eight is a variable, the basin of any or all of which may vary in depth from moment to moment which gives rise to a basin of attraction which is the practitioner's cognitive process. If the basins of all eight are deep, then the basin of the practitioner's cognitive process is also deep. The trajectory in phase space describes this process. Thus, the Eightfold Path should be seen as a complex, dynamic lifestyle.

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[277] The sutta pitaka classified the four stages of meditation as follows: stream enterer (Pali. Sottapanna)., once returner (Pali. Sakadagami)., non-returner (Pali Anagami). and liberated (Pali. Arhat). Kamalashila designated 10 stages of attentional development in *Stages of Meditation* culminating in "calm abiding" or quiescence (Skt śamatha). Wallace, B.A. (2006). *The attention revolution: Unlocking the power of the focused mind* Boston: Wisdom Publications.

[278] The Sanskrit term *mārga* literally translates as path.

6.3. Dependent Origination

According to the Doctrine of Dependent Origination, all phenomena (including mind and Self) exist due to interdependent causes and conditions and cannot be understood independently.

The twelve links of Dependent Origination are described in two ways: as occurring in three successive lives and as occurring in one lifetime. The links are the same in each case. In the former description, three successive lives, (past, present and future), are as follows:

(past life): 1) ignorance 2) action 3) consciousness (3a) cause consciousness (present life): 3b) effect consciousness) 4) name and form 5) sense spheres 6) contact 7) feeling 8)attachment 9) grasping 10) existence (which ends in death) (future life): 11) birth, 12) old age and death.

Another way to describe the twelve links is to conceive of them all as occurring in the present life. I will discuss both interpretations.

ITB contends that the Doctrine of Dependent Origination has three progressively deeper levels of interpretation.[279] At the first level, human suffering is said to arise due to twelve specific causes and conditions. The twelve links in the chain of causation trace the causes of the cycle of suffering and means of its release. Modifying one or more of these may ameliorate or eliminate suffering. The implication is that human suffering exists conditionally and impermanently. The mind in its natural state is conceived as primordially clear, according to ITB, but is clouded by adventitious stains which impair pure or unobscured perception. Thus, humans are trapped in a cycle of repeated births and deaths due to these interlinked causes and conditions.

At the second level of interpretation, the Doctrine is considered to be conventionally or epistemically but not ultimately (ontologically) real.[280] That is, the links function merely to

[279]H.H The Dalai Lama (2000). 35-37.

[280] The distinction between conventional reality and ultimate reality does not quite track the distinction between methodological versus metaphysical approaches. The reason is that conventional reality is not a method; rather it is the experience of reality as it appears to be (to one who is ignorant as to the true nature of reality).

explain the causes of suffering and means of its release. Yet it would be false to say that the links do not exist. They exist conventionally in the sense that the links explain the nexus of causation in which most humans are entrapped, and they appear real to the conventional mind (a mind which misperceives appearances as reality). For example, death appears conventionally to be something inevitable and inherently existing. However, according to the ITB teachings, when ignorance is eliminated the chain of dependent origination is broken; birth, old age and death no longer occur.

At the second level of interpretation, dependent origination is understood to apply to all phenomena insofar as everything is composed of parts and the whole does not exist independent of its parts. So, for example, under analysis, a table is said to exist dependent upon its parts and the parts, in turn, can be further and further broken down until the distinction between subject and object is dissolved (which is the third or deepest level of interpretation of the Doctrine). The analysis is captured by Dzogchen Penlop Rinpoche:

> "It is important to remember that the purpose of analysis is to determine if a particular object truly exists on the absolute [or ultimate] level. That is what we are looking at in this process. We do not question whether it is there, before our eyes, on the relative [or conventional] level. In the very beginning, before our analysis, we have both an object and a subject: an object of perception and a perceiving consciousness. During the analysis, when we arrive at a more subtle level of the object's material existence, then the subject side—the perceiving consciousness—apprehends it. When we reach the final stage of finding "nothing at all," then the perceiving consciousness is transformed. It is no longer a "perceiving" consciousness because the object of perception and the act of perception are discontinued. The true existence of the object is no longer there—what is there is a transparent appearance, and an equally transparent awareness. There is no solid existence anywhere. Without solid existence, there is no way to delineate or define identity. Therefore, the separation between Self and other, subject and object, becomes illusory. What occurs in that moment is the direct apprehension of the ultimate nature of mind which is beyond the subject-object split" [281].

According to the second level of interpretation, all phenomena consist of parts and exist dependent upon causes and conditions. When the parts are dissected at more and more subtle levels and the causes and conditions are analysed, the separation between Self and

[281] Dzogchen Ponlop (2008). *Mind beyond death*. Ithaca, N.Y.: Snow Lion Publications 64-66.

object disappears and the emptiness of phenomena, the deepest interpretation of the Doctrine is apprehended.

At this third and deepest level of interpretation, all phenomena are imputed to exist dependent upon linguistic designations and concepts. The Self, for example, is said to exist in such a manner. But when one searches for that which the term 'Self' designates, no such entity can be found. Therefore, the Self too is conventionally and not ultimately real. Rather, Self and all phenomena are said to be 'empty' (skt. *śunya*) of inherent existence. A more detailed description of the twelve links follows.

6.3.1. Ignorance

The crux of the human dilemma is ignorance which is of two types: primordial (basic) and secondary. Primordial ignorance consists of misconceiving persons and other phenomena as inherently existing, independent, and free of formative causes and conditions. Typically primordial ignorance is conceived as the condition into which virtually all humans are born. In fact, we nominally exist, that is, in dependence[282] on others, on the body parts of which we are composed and on the conditions necessary for survival. Analogously, we might misconceive a table as inherently existing, free of causes and conditions, whereas it nominally exists in dependence on its parts, legs, top, etc, and on the conditions which fostered its creation. Secondary ignorance follows from primary ignorance and consists of misconceiving the effects of non-virtuous[283] actions. According to the ITB understanding of cause and effect, non-virtuous actions inevitably create negative consequences for oneself (negative *karma*). For example, while one may believe that acting in one's own interest without considering the effect upon others may bring benefit to oneself, this may not actually be so either for oneself or for others. Since we are socially interdependent and therefore structurally coupled, failure to take account of the effect of a self-centred action on others may hurt oneself even if one does not perceive this. The Dalai Lama has said that

[282] The term "dependence" when used in the Buddhist context should not, I believe, be taken as a modal claim. The causes and conditions according to which any phenomena exist are too extensive and attenuated to claim a supervenience relationship.

[283] From an ITB perspective, non-virtuous actions are those that tend to reinforce ignorance and keep one trapped in "delusion". Such actions may or may not be considered to be immoral from another ethical perspective.

if one is to be selfish they should be wisely selfish. By this he meant that if one truly wants to benefit themselves the best way to do this is to benefit others.

As I have shown in chapter three, one's actions and even thoughts structure neural circuitry, creating a greater likelihood that similar sorts of actions or thoughts will recur. Repeated self-serving actions without regard to the consequences to others strengthens neural circuits which tend to perpetuate such actions. Conversely, repeated altruistic actions create a greater likelihood that similar actions will recur. Since humans are socially coupled, behaviour has consequences both for oneself and others.

Primordial ignorance is extinguished by ceasing to conceive and experience Self as independent, inherently existing free of causes and conditions, and by realizing the non-existence of an enduring Self. In modern parlance, Selves are ever-changing, complex, impermanent processes, never static states.

Since primordial ignorance is a condition into which virtually all human are born, its basin of attraction, as a generalisation, is so deep that it is the precondition for many (but not all) thoughts and actions. However, it need not be one's destiny and ITB practices are prescribed to eliminate such ignorance. It is difficult but not impossible for one's life trajectory to escape the attractor of ignorance. Higher cognitive processes such as determination, persistence and diligence are required. These processes and practices taken together lessen the depth of the basin of attraction of ignorance. This is a process that unfolds over time and may be well described by DST. The trajectory in phase space represents the process (progress) that the practitioner undergoes as a result of the influence of all the practices. A point on the trajectory represents the state of ignorance of the practitioner at a particular moment in time.

Likewise, each of the twelve links (and not only ignorance) contribute to the elimination or solidification of suffering. There is a bi-directional feedback loop between each of the eleven links and ignorance. For example, ignorance strongly influences one to act non-dharmically, thus deepening the basin of attraction of ignorance. But one may nevertheless choose to act in such a manner as to lessen the depth of its basin of attraction; for example, by engaging in contemplative practice. A small change in initial or progressing conditions may lead to a significantly dramatic result.[284]

6.3.2. Action

Due to basic ignorance, one may act in furtherance of a perceived benefit, misconceiving the existence of an independent Self. If the action impacts oneself or others negatively, then negative consequences may arise and if positive, then positive consequences may arise. Neither case conduces toward liberation since both misconceive the nature of the agent and the action. For example, a wealthy real estate developer enters into multiple contracts in furtherance of a real estate development. Market conditions change and the developer declares bankruptcy, leaving all the contractors with substantial losses. The developer may believe that he is obtaining a benefit for himself, not taking account of the coupled relationships he has formed. So, he may not realize at the time the potential consequences for future development deals, for his reputation and financial standing as a businessman or for his position in the community. Most importantly, from the ITB perspective, such an action taken without consideration of the impact on the complex web of relationships fails to take account of his interdependence as a member of this web.

Birth as a human is considered fortunate so the action bringing about human birth is thought to be positive. *Dharmic* ethics are thus thought to be vital in the creation of positive *karma* leading toward liberation in this or a future human life. One may improve the circumstances of one's lives by learning about the relationships between actions and their effects and acting so as to create the best possible circumstances in the future. According to this view, one becomes freed from ignorance by realising[285] the interdependent, complex, recursive nature of the Self and acting in accordance with this fact; that is, avoiding both types of ignorance and the three poisons.

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[284] A frequently debated question in Buddhism is whether enlightenment occurs suddenly or gradually. The question posed is in the form of dichotomy. If the question is considered from the dynamic systems perspective the answer might be much like the answer given by the Zen master. Yes!

[285] Realisation, in the ITB context, is given both a cognitive and phenomenological meaning. It recognizes a transformative element roughly similar to, but not the same as, the Eureka effect.

An action which leads to *karmic* consequences must consist of five factors: intention; thought that properly identifies the object; preparation for action; successful completion; and non-reversal of intention before the action is completed.[286] For example, a landlord intends to evict tenants from his building so that he can lease to new tenants and substantially increase rents. He targets the currently residing tenants with a series of unpleasant and dangerous conditions and succeeds in forcing them to leave. After these tenants have vacated the premises, the landlord re-leases the apartments at substantially increased rents. In this example, all five criteria are met, and the landlord will reap the *karmic* consequences of his actions; cause consciousness and effect consciousness, the next link in the chain of causation will arise. Note that the *karmic* consequences of actions cannot, in principal, be judged by the nature of the action alone since a subjective element, the intention of the actor, is crucial.

6.3.3. Cause Consciousness and Effect Consciousness

When an action is complete, a mental disposition imprints on consciousness. This is referred to as cause consciousness. It may be either positive or negative. Cause consciousness creates a predisposition, thereby creating the mental disposition and circumstances of the next lifetime (effect consciousness). In other words, the content of consciousness creates the circumstances of future lives and drives both birth and death. In this sense, *karma* as the consequences of one's action, must be seen as a psychological phenomenon. Cause consciousness in this sense refers to a mental state in a past life resulting in a mental predisposition in the next life of which one, most likely, is not aware.

This recursive cycle--- mental dispositions leading to dispositions to act resulting in life circumstances which lead to further mental dispositions---resonates with the enactivist mind-life continuity thesis.

[286] H.H. The Dalai Lama (2000). *The meaning of life: Buddhist perspectives on cause and effect.* Boston: Wisdom Publications. 12.

6.3.4. *Nāma-Rūpa*

Nāma (Skt) refers to consciousness and the mental factors that accompany it as a result of cause consciousness. *Rūpa* (Skt) refers to the body at the time of conception. Taken together, nāma-rūpa refer to the psycho-physical entity which is structured, in part, by consciousness at the time of conception.

6.3.5. Six Sense Spheres

This phrase designates six sense powers or potentials- ear, eye, nose, tongue, body and mind- which eventually develop into the respective senses, or consciousnesses. These are believed to develop at different moments (depending of the specific sense) within the womb. The sense spheres refers to the 'subtle matter or potential' within the senses. From the perspective of ITB, the senses are thought to be activated not by the physical sense organs but rather by the potential within the organs. The subtle matter or potential refers to that facility in the physical sense organ that allows the sense to operate.

6.3.6. Contact

Contact designates the actual act of perception, the concatenation of object, sense organ and perception in consciousness.

6.3.7. Feeling

Through contact with the senses and external objects, discriminations (preferences and aversions) denominated either as pleasant, unpleasant or neutral are experienced and lead to attachment or aversion. These bear some similarity to what contemporary psychologists refer to as emotional tone. Pleasant discriminations impel one to seek more of the same. This leads to the next link, attachment. Conversely unpleasant discriminations tend to lead toward aversion.

6.3.8. Attachment

This link refers to the desire to continue to experience pleasure, to avoid pain and for a neutral feeling to morph to pleasure and not displeasure. The term strictly refers to the specific attachments which nourish the *karmic* potency which will produce the next lifetime.

6.3.9. Grasping

This link refers to an increase in attachment, that is, clinging to pleasant experiences and averting the unpleasant. Near the time of death, attachment and grasping are said to shape the future life. For the practitioner, it is important to realise that near the time of death, one's mental disposition is said to determine one's future life (in section 6.12. and in chapter 7, I discuss ITB practices during dying and in death). Both attachment and aversion are cognitive processes that create the *karmic* seeds bearing fruit in the future. Practitioners are therefore advised generally to avoid them but particularly at the time of death; at that time, one should focus on cognitive practices leading to liberation or if possible, to remain in the natural state of mind, pure awareness devoid of object. This *Dzogchen* (Tib) practice is sometimes referred to as 'non-meditation' and is considered in Indo-Tibetan Buddhism to be the ultimate practice. This practice is discussed in section 6.10.

6.3.10. Existence

This link refers to the fully activated *karmic* potency at the last moment of the current life that results in the next lifetime.

6.3.11. Birth

Birth refers to the first link in the third (future) lifetime arising from the 10^{th} link (existence).

6.3.12. Aging and Death

This link follows necessarily from birth in this lifetime.

To briefly summarize, the twelve links of Dependent Origination described above may be conceptualized as occurring in three successive lives. From this perspective, the twelve links lead to one's continuing rebirth within the cycle that constitutes, what ITB refers to as, ignorance. But these twelve factors also exist within each lifetime, not serially, but rather, simultaneously. To provide an analogy, Kalu Rinpoche gives the example of the ringing of a bell. He asks, what causes the ringing? Is it the clapper, the hand that moves the bell, or the ear that hears it? All must exist simultaneously to be heard. Likewise, the twelve links must all exist at once for conditioned existence to occur, either in one life or in multiple lives.[287] But to extend the analysis of Kalu Rinpoche's metaphor, what factors cause the bell not to be rung? Answer: the elimination of any of the factors mentioned above. Likewise, each of the twelve links are necessary simultaneously for conditioned existence and the elimination of anyone cuts the links in the chain, leading to freedom.

The second interpretation of the Doctrine of Dependent Origination suggests that all links occur in one lifetime. In one lifetime the same links as describe above perpetuate suffering. Again, these are: 1) Ignorance of the true nature of Self which leads to: 2) Actions taken based on the: 3a) Erroneous view of Self (cause consciousness) which: 3b) Creates mental predispositions (effect consciousness) bringing about: 4) Physico-physical person (nāma-rūpa: body and mental factors) with: 5) Sense spheres which activate the physical senses: 6) Contact is made by the concatenation of object, sense organ and consciousness leading to: 7) Feeling which arises due to discriminations as to the pleasantness, unpleasantness or neutrality of experience which leads to: 8) Attachment, that is, the desire to continue to experience pleasure, avoid pain which leads to: 9) Grasping, that is, seeking, an increase in attachment- clinging to pleasant experiences, averting the unpleasant: 10) Existence arises as the activated potency leading to: 11) Birth: 12) Old age and Death.

[287] Kalu Rinpoche (1997). *Luminous mind.* Boston: Wisdom Publications.43

It is important to observe that in describing the links in a single lifetime it is necessary to describe them serially rather than simultaneously. The serial description is misleading but linguistically necessary. This is an example of how language structures concepts, leading one mistakenly to think of causality in this instance as linear rather than complex. What would it take to describe them as happening simultaneously? I shall try this as a thought experiment.

When I try to do this, I am at a loss. I try to let go of the descriptive element and somehow conceive the links as twelve elements interacting simultaneously. I find this too difficult to do and my mind stops. There is no mental content. The ITB view is that language and concepts skew the deeper nature of the dynamics and nature of dependent origination. Stopping cognition is a potential opening to deeper awareness. According to this view, the real nature of dependent origination and all experience is empty. Again, Kalu Rinpoche:

> "The empty nature of what exists at the relative level is what we call ultimate truth. Truly understanding dependent arising allows one to go beyond the conditioning of the relative or conventional level and attain the peace and freedom of unconditionality. When you completely understand dependent arising you also understand emptiness. And that is freedom."[288]

Kalu Rinpoche makes it clear that the twelve links also designate the way that liberation can be attained. The root of ignorance can be cut by: 1) acting, thinking and experiencing based only upon the contingently existing Self: 2) which creates beneficial actions leading to: 3) positive mental predispositions: 4) which then leads to recognition that mental dispositions and body with structural integrity: 5) sense spheres then operate free of perceptual and cognitive bias which gives rise to: 6) contact free of bias resulting in: 7) feelings/discriminations as to the true nature of the contact: 8) freedom from attachment and: 9) free of grasping resulting in: 10) fully activated potency culminating in: 11) liberation (no birth or death).

Again, this is misleading because any of the links can be leveraged to extricate oneself from the bondage of dependent arising. One may cut the root of ignorance by interceding at any point in the links. For example, one may attack one's tendency toward attachment

[288] Ibid.

and grasping. This then weakens and eventually eliminates all the other links including ignorance. Or one might train in recognizing the contingent nature of mind and body which also weakens all the other links. In this way, it becomes clear that the twelve links are interdependent and causally complex.

Paradoxically, one may also treat the twelve links serially, and that would also be an effective approach to dispel ignorance. Dynamic causality and linear causality are complementary pairs (in Kelso's sense) so both are considered effective methods for attaining liberation.

The ITB doctrine of dependent origination is an excellent example of complex causality best described by DST. Multiple elements act interdependently, each with a basin of attraction that may vary in depth depending upon the interaction of the elements. Some or all elements are metastable. Metastability refers to the tendency of one or more elements to simultaneously realize two competing tendencies: the tendency of the individual components to couple and the tendency for the components to express their independent behaviour.[289] These two competing tendencies create dynamic instability. The practitioner seeks to create a phase portrait in which the basin of the ignorance control is shallow or better yet, eliminated. The competing tendencies may be identified using the example of the misconceived Self. The typical ITB practitioner is trapped within the twelve links but seeks to be free. On the one hand, the coupling of ignorance of the true nature of the Self with the other links acts to keep one imprisoned. On the other hand, in seeking one's freedom through practice, one expresses ones interdependence as for example, in the practice of *tonglen*. In this meditation, the practitioner "breaths in" the suffering of others and "breathes out" to them his well-being. In this and similar practices, the practitioner seeks to make all the basins of attraction of ignorance shallower and all the basins of attraction of wisdom deeper.

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[289] Kelso, J.A.S. (2012). Multistability and metastability: understanding dynamic coordination in the brain. *Philosophical Transactions of the Royal Society Biological Science* 367. 906–918. doi:10.1098/rstb.2011.0351.

6.4. The Three Jewels

The Four Noble Truths and Dependent Origination are core Buddhist doctrine, referred to as *dharma* (skt). *Dharma*, *Buddha* and *Sangha* are referred to as the Three Jewels and these give guidance as to how one is to relate to key aspects of Buddhism. The Three Jewels are so important to Buddhism that the clearest indication that one is a Buddhist is to take a vow, known as "Refuge in the Three Jewels". Not surprisingly perhaps, these three elements can be understood to interact dynamically. Below I will briefly indicate how this interaction may be described.

6.4.1. *Buddha*

According to ITB, the *Buddha* is considered merely a mortal man, with all the problems and challenges of humans. But he constitutes an example of how one can transform the mind by the implementation of the Eightfold Path. Since he is "merely mortal", his advice is not considered authoritative. Rather, the practitioner is advised to try the practices prescribed and experience the results for oneself. In other words, each practitioner must make up his own mind as to the value and efficacy of the dharma and not rely blindly on the example of the *Buddha*. But on the other hand, the *Buddha* and many others, following his instructions, succeeded in alleviating their suffering by the methods he prescribed. So just as an experienced teacher can lead the inexperienced student so the *Buddha* can lead the inexperienced aspirant. The *Buddha* is compared (in the *dharma*) to a physician who has prescribed medicine to alleviate suffering. It is because of his experience and training that he has the ability to prescribe at all.

In later ITB, the teacher is likened to the *Buddha*. One is exhorted to see the teacher as the embodiment of the *Buddha* and treat him as such. But this is not a prescription to follow blindly. Rather one is initially required to test the teacher and follow him only to the extent that his behaviour and teachings accord with dharma. For instance, in the event that the teacher violates ethical bounds according the Eightfold Path, the teacher is to be excoriated.

6.4.2. *Dharma*

Just as the *Buddha* is not to be followed blindly, so too the *dharma* is not to be followed mechanically. Context matters, states of mind matter, intentions of agents matter and dharma may vary with changing circumstances. Therefore, in a given situation where *dharma* may appear to be violated, the intention and subjective state of mind of the actor may need to be considered to determine whether, in fact, a violation has occurred. There is no such thing as *res ipsa loquitor* (the act speaks for itself). The story is told of the *Buddha* who in a former life killed a person, seemingly a clear violation of *dharma*. But it is explained that the *Buddha* (who had attained omniscience[290] at this point in his development) had foreseen that the man he killed would have killed another had he survived. Out of compassion, the *Buddha* killed the man to spare him the suffering of the *karma* he would have incurred had he committed the murder. According to the ITB understanding, because the intention of the *Buddha* was completely pure, as he acted purely out of compassion, no *karma* could be attributed to the act and it is thought *dharma* was not violated. As one might imagine this is a controversial issue as it can give apparent justification to a teacher to act cruelly and with impunity. And not surprisingly, it has served as justification for immoral behaviour. The weight given to the subjective intention of the teacher can create problems as the example below (section 6.5.3) demonstrates.

The subjective intention 'loophole' does not however give one *carte blanche* to act as one might choose since intention is not only conscious but unconscious, the result of *karma* from all one's previous lifetimes. On the one hand, an individual has responsibility and freedom to pursue the path to liberation (following the *dharma*) in their own way. On the other hand, they are bound in ignorance and so constrained in their ability to clearly perceive and consequently to act beneficially. For example, an action may be performed which unconsciously reinforces the belief in the independent Self. In such a case, although one might believe they are acting to further their liberation, in fact they are achieving the opposite. These examples demonstrate the complexity of the interrelationship between the Four Noble Truths, which contemplate the limits as well as possibility of freedom from

[290] In ITB, it is believed that advanced practitioners develop omniscience, which provides the ability to see the events of one's own and others past lives as well as events in the future.

suffering, and dependent origination, which may (or may not) constrain liberation. Multiple factors act as control parameters and are coupled such that a change in one might cause effects in all others. Thus, the phase portrait of the aspirant is dynamically unstable, constantly in flux. The project of the aspirant is to deepen the basins of attraction of each of the eight means described in the Eightfold Path thus making shallower the basin of attraction of ignorance, the first of the twelve links of Dependent Origination as well as all the other links.

6.4.3. *Sangha*

Sangha refers to the community of ITB practitioners with which one is associated. If one is a monk the sangha is the monastery. If one is a lay practitioner, the *sangha* is the group or community of practitioners of which one is a member. The significance of the *sangha* to ITB cannot be overemphasized. ITB is a social religion. Most obviously, the *sangha* provides practice and social support to its members. Recall the discussion of the importance of interpersonal relationship in chapter 4. Motivations rise and fall, questions are raised and answered by *sangha* members. The fabric of the community binds the members into a cohesive whole so each member may be a more effective practitioner. But the element of support has a transcendental aspect in that the sangha also includes the lineage of realised masters, *bodhisattvas*, to whom one may pray, or who might serve as examples of successful practitioners. The basic idea is that *bodhisattvas* have been successful in transforming their minds and that like *bodhisattvas*, all humans have the capacity to transform their minds. The difference between the two is that b*odhisattvas* have been successful whereas most practitioners have not yet been. Depending on the practitioner's inclination one might pray to them for intercession or one might consider the wisdom mind of the *bodhisattva* to be inseparable from one's own wisdom mind. This might seem to be a different and disparate view of the reality of the *bodhisattva* mind, but from the practice perspective, these two views are complementary. Complementarity exists insofar as these two methods suit different inclinations and abilities of practitioners. While the recognition that the wisdom mind of the *bodhisattva* is inseparable from one's own mind is considered a more sophisticated understanding, it is not at odds with intercessionary prayer.

There is a complex dynamic amongst the elements of the Three Jewels well demonstrated by a recent example within a well-known international ITB sangha. The teacher had been accused of sexual and physical abuse over the years. This behaviour unsettled some members of the *sangha* who withdrew from the group and many stayed. One *dharma* justification given for the behaviour was the lineage tradition of "crazy wisdom". Properly speaking, crazy wisdom is not *dharma* proper but rather, an ITB tradition in which certain lamas engage in unconventional behaviour designed to expedite self-realisation of practitioners. The idea is that the lama has pure motives and has the wisdom to perceive (because of his clarity of mind) what behaviours will ultimately benefit the student. According to the ITB tradition, such masters act for the benefit of the student and not to further their own self-interest. It is easy to see that such a tradition can potentially provide the rationale for abuse. Given that the master is encouraged, in the tradition, to be considered the very embodiment of the *Buddha* and enlightened *bodhisattvas*, it can be difficult for *sangha* members to differentiate between the personal motives of the all too human teacher and the compassionate motives arising from the so called "enlightened wisdom mind" of the master. Changes of fact in one of the three jewel elements might lead to that element becoming a stronger attractor. In this instance, the opinion of the Dalai Lama, the *de facto* head of the ITB tradition (thereby a guiding influence to *sanghas*), would weigh heavily and influence many members of the *sangha*. The *Dalai lama* weighed in against the behaviour of the teacher and the members of the *sangha* were split as to the motives of the lama. Some remained within the *sangha* and some departed. Given the circumstances, it is difficult to say whether more members left because of the *Dalai Lama's* denouncement, but given his authoritative position, one may assume that his view had significant impact. In this example, *Buddha* (in the form of the teacher), *dharma* (as expounded by the *Dalai Lama*) and *sangha* clashed and created a dynamic challenge. In this scenario, *Buddha* and *Dharma* are both strong attractors, each having a strong but different effect on each member of the sangha. Thus, some members were pulled into the basin of the *Buddha* and others were pulled into the basin of the *Dharma*. It should be clear that the complex dynamic described is by no means limited to Indo-Tibetan Buddhism. Rather, complex dynamics are commonplace in many multifactual processes.

I have said previously that ITB concepts, teachings and practices constitute a symbiotic package designed to transform the mind. Some of these concepts of been mentioned above. In section 6.5 to 6.9 additional concepts are mentioned all of which support meditation practice (section 6.10).

6.5. No Self

In his second discourse after his enlightenment, referred to as the Second Turning of the Wheel of *Dharma, Buddha* taught the non-existence of the Self/soul (Skt.*nātman*). In Hindu India, the existence of a permanent, independent Self (Skt. *ātman*), had been axiomatic. The *Bhagavad -Gita* (Song of the Lord) taught that one should do one's duty in accordance with the caste into which one was born. *Buddha* turned this ethic on its head. Teaching in Pali, the language of the people (in contrast to Sanskrit, the learned language of the priestly class) the *Buddha* taught the non-existence of the soul/Self. He taught democratically to anyone who would listen to discourses he gave publicly. And he taught that anyone who followed the Noble Eightfold Path, regardless of caste, could achieve liberation. Analysing the components of body, speech and mind he argued that nothing permanent could be found. Body, sensations, perceptions even consciousness, were all in flux and since these elements foster craving and desire which, in turn, create suffering, the mind should be trained to divest attachment even to them.

What the *Buddha* meant by the term 'no-Self' requires explanation. While tradition varies as to interpretation, one perspective is that the *Buddha* was making an ontological statement; that at the deepest level of reality, the Self did not exist as an abiding, independent entity. But the claim was later made by Mahayanists that the Buddha was making an epistemological statement. In other words, he was not saying that Self did not exist at all; rather, the Self has experiential or relative validity. According to the underlying premise, what ultimately exists is that which is unchanging, independent and not composed of parts. The Self is interdependent and everchanging, so not ultimately real. The doctrine of two truths was thus born. The Self was both real in some sense and not real in another, that is, relatively or conventionally but not ultimately real. The primordial cause of suffering according to ITB is the belief in a permanent, independent Self. We take as ultimately real what, in fact, is only relatively real. Due to ignorance of the ontological status of Self, other problems arise.

The doctrine of no-Self is a strong parameter, in the sense of being a 'core' element shared amongst many different Buddhist schools. This element is coupled with many elements of ITB doctrine and practice such as compassion practices (no empathetic boundary between Self and other), meditation practices (no abiding Self to be found phenomenologically), and the Four Noble Truths (ignorance of the nature of Self as the cause of suffering). It was and continues to be the practice methodology of ITB to leverage the interdependence of all the conceptual and practice attractors to transform the mind of the practitioner. ITB was the first dynamic systems approach to personal transformation.

6.6. Impermanence

Self and all phenomena are in flux moment to moment and impermanent according to ITB. All that is created is ever changing and eventually crumbles; that which is alive changes moment to moment and eventually dies. According to ITB grasping, craving and attachment to the desired continuity of that which is everchanging and impermanent is a cause of suffering. This does not however mean that one should be indifferent to the world. Rather, the import is that one should recognize that change is inevitable and not act or think contrary to this fact.

Impermanence is a dynamic concept and a strong attractor coupled with every concept and practice in Buddhism. The ITB concept of impermanence is resonant with dynamic systems which are in flux moment to moment. And when such a system appears to be stable, rather its state is more likely to be dynamic unstable.

6.7. Two Realities/Truths

I have referred repeatedly to the doctrine of two truths. It is fundamental to understanding the complexity of ITB. Each of the four schools of ITB has given a somewhat different interpretation of the two truths. For my purpose however, we need not concern ourselves with these differences. According to one philosophical view, there are two levels of reality. One level is empirical, relative and phenomenal. It is at this level that cause and effect, appearances, concepts, language, science and the like are operational. It is conventionally real but ultimately illusory. The fact that it is termed relative and illusory does not denigrate it. Rather, it is necessarily functional. The second level is considered ultimate. It is often referred to as emptiness. It refers to authentic experience beyond illusion. This is what is referred to as nirvana or enlightenment. It is beyond concept and language and so not described. From the perspective of ITB, suffering is caused by mistaking what is conventionally real for what is ultimately real, in other words, not recognizing the emptiness of the relative. Kalu Rinpoche gives the example of a nightmare.

> "When someone has a nightmare, that person suffers. For the dreamer, the nightmare is real; in fact, it is the only reality the dreamer knows. And yet the dream has no tangible reality, and is not actually 'real'; it has no reality outside the dreamer's conditioned mind, outside the dreamer's own karma. From an ultimate perspective, it is, in fact, an illusion. The dreamer's illusion is in failing to recognize the nature of his experiences. Ignorant of what they actually are, the dreamer takes his own productions—the creations of his own mind—to be an autonomous reality; thus deluded, he is frightened by his own projections and thereby creates suffering for himself. The delusion is to perceive as real what is actually not."[291]

Yet, from a conventional point of view the nightmare does exist but from the ultimate perspective it does not. It is often said that the two truths steers a middle course between the extremes of eternalism and nihilism. The ultimate truth of emptiness does not imply that phenomena do not exist. Phenomena do exist but conditionally and impermanently. The relevance of the two truths is its application to the reality of mind. The discursive mind is conventionally but not ultimately real. The ultimate nature of mind is empty.

6.8. Indo-Tibetan Buddhist Conception of Mind

ITB concedes that the gross or physical manifestation of mind is implemented via the brain. This would include, cognition, emotion, some dream states, etc. But they deny the basic premise of some varieties of physicalism that mind is *only* implemented by brain. Rather, the claim is that the natural state of mind, pure consciousness without object, a unitary state/process/experience , is not a brain function. They claim that once the brain is non-functional, the natural state of mind arises in the after-death state but typically is

[291] Kalu Rinpoche (1997). 42.

obscured by subtle trace mental tendencies from one's life. Taken literally, the ITB account of mind would appear to challenge the naturalistic account since naturalism would not acknowledge mental function after death. In particular, enactivism is committed to the mind-life continuity thesis in light of which it is clear that mind function ceases at death. This is a challenge which I consider in chapter 7. I argue that ITB accounts should not be lightly dismissed as there is a long tradition, including many eyewitness accounts, of *currently* inexplicable physical phenomena accompanying the after-death state. This is fertile ground for investigation. It may well be that these phenomena can be accounted for naturalistically or that the current understanding of naturalism may need to be supplemented and perhaps expanded. The burden of proof for demonstrating the viability of the ITB account of mind with regard to after-death states would most likely be a controversial subject between ITB practitioners and scientists. In any case, the study of the dying mind particularly the study of those individuals who have practiced meditation for an extensive period of time may shed new light on the function of the well-trained mind.

The ITB doctrine of two levels of reality or truth plays a prominent role in the understanding of mind. Mind is said to have two aspects, the discursive, discerning, dualistic mind and a deeper aspect referred to as the 'nature of mind' (Tib.*rigpa*, Skt.*sugatagarbha*). The former, which appears to inherently exist but, in fact, depends upon the survival of a person, is considered to be conventionally real (hereafter referred to as conventional mind). It plays an essential role in our navigation of the conventional world but owes its existence to the nature of mind. *Rigpa*, which continues to abide lifetime after lifetime, is considered to be ultimately real (though, from the perspective of ultimate reality, it too is empty). What is the relationship between the nature of mind and conventional mind? There is a sense in which the question is meaningless as 'relationship' assumes the existence of two things. But the ITB position is that, from the perspective of ultimate reality, there is only one thing which, to the conventional mind, is misperceived as two. Restated from a western perspective, the question might be rephrased, 'in terms of conventional reality, what is the relationship between *rigpa* and conventional mind'? Conventional mind certainly *depends* on *rigpa* since it is considered an emanation of it. But it is only partially *determined* by *rigpa*. It is determined by *rigpa* insofar as that is its essence. Therefore, conventional mind is, by its very nature, pure and so the obscuration of ignorance can always be cleansed. However, there is another factor that determines the content and function of the conventional mind: *karma*. According to ITB, it is *karma* that propels ignorance from the past to the present and obscures *rigpa*. *Karma*, a form of psychological momentum based upon past deeds, transmigrates from lifetime to lifetime, is embossed (so to speak) upon the mental continuum, and conditions cognition. But *karma* can be cleansed by meditation, contemplation and purification practices.

6.8.1. Non-Physicalism of Mind

The ITB understanding of mind is properly categorized as non-physicalist as described above. While the conventional mind may be dependent, in part, upon brain function this cannot be said of *rigpa* which is said to be very subtle or immaterial. As the argument goes, if *rigpa* was physical, then it would be composed of parts and be dependent on them. But this could not be the case because *rigpa* is said to continue to function after the body ceases function. Furthermore, as discussed below, the relationship of *rigpa* to the conventional mind is, depending on one's philosophic perspective, either paradoxical or problematic. According to ITB, conventional mind is said to be an emanation of *rigpa* analogous to the rays of the sun which are an emanation of the sun. However, that analogy breaks down on closer examination because, in the case of the sun and its rays, both are physical whereas this is not the case with conventional mind and *rigpa*. Furthermore, the sun and its rays are normally considered as separate whereas *rigpa* and conventional mind are considered different aspects of one entity. According to ITB, one attribute of *rigpa* is pure, primordial, nondual awareness. The traditional analogy is to the vastness of the sky. It cannot be denied that conventional mind is heavily dependent upon and determined by neural correlates, the Indo-Tibetan Buddhist might argue. However, it is by no means clear that very subtle states of mind such as so called 'clear light' states have neural correlates.[292]s

If we are to model the relationship between mind and ignorance, along the lines of DST, we might first accept the ITB view that *rigpa* and the discursive mind are two aspects of one entity. The basins of attraction of these two aspects of mind will vary in depth as will the basin of ignorance as the ITB practitioner diligently develops their practice using PCTs.

[292] H.H. The Dalai Lama (1997).164-171.

Here is the analysis: Prior to ITB practice, the novice's basins of attraction of ignorance and the discursive mind are deep and together, they initially direct the trajectory through phase space toward the attractors of ignorance and the discursive mind. The trajectory represents the deluded cognitive activity of the novice.

When the novice begins to utilise PCTs, the shape of all three basins of attraction begins to change. The basins representing ignorance and discursive mind get shallower as the basins of *rigpa* and ITB practice become deeper. At some point, there is a phase transition in which the basins of *rigpa* and ITB practice become stronger than the competing basins. Then the trajectory in phase space tends toward the attractor of wisdom, the basin of which gets deeper as practice continues. After the phase transition, the trajectory in phase space represents the deepening wisdom of the practitioner.

6.8.2. Non-Reductionism of Mind

While *rigpa* is ultimately real according to ITB, conventional mind cannot be epistemically reduced to it in the same way the reductive physicalist would say that mind can be reduced to brain function. Since conventional mind is said to be an indivisible aspect of *rigpa*, it cannot be eliminated from ITB ontology.

6.9. Embodiment in Indo-Tibetan Buddhism

Indo-Tibetan Buddhism conceives of mind and body as a complex unity, a singular entity albeit instantiated in three scales: gross, subtle and very subtle.[293] As with all ITB conceptual schema, the purpose of the tri-level schema ultimately is to aid the practitioner in the realization of the most subtle level of mind-body. Typically self-identification is with the gross level. Meditation allows the experience of the more subtle scales. The tri-scale schema allows the practitioner to integrate the three scales and ultimately to identify with the most subtle scale.

[293] Padmasambhava, Thurman, R. (Trans.) (1994). *The Tibetan book of the dead.* London: Harper Collins.

The gross body consists of flesh, blood, bone, brain, nerves and so on. These can be analysed as five elements: earth, water fire, wind and space. Gross mind corresponding to the gross body is the six-sense consciousness, five perceptual senses and mental sense consciousness which operates through the nervous system.

The subtle body consists of the energetic pattern structuring the nervous system which allows this system to function. It consists of subtle nerve channels (skt *nadi*) that radiate in and out of subtle energy centres (skt *chakras*). The energy centres are strung along three main nerve channels. Within this network of channels are subtle "drops of awareness" that are moved through the channels by subtle energies called winds. "The subtle mind corresponding to these energies and structures consists of three interior states that emerge in consciousness the moment subjective energy is withdrawn from the gross senses".[294] These states are referred to as luminance, radiance and imminence, the latter of which is the deepest state of the subtle mind.

The most subtle body is referred to as the "indestructible drop". It is an immaterial energy pattern located in the energy centre of the heart. The immaterial mind that corresponds to this energy is called "transparency". At this most subtle scale, there is no distinction between mind and body. This most subtle scale is considered to be ultimately real, which is why the ITB conception of mind is said to be immaterial.

In the process of dying, the final step is the movement of energies to the heart centre. Advanced practitioners remain engaged in a death meditation at this point and the region of the heart allegedly remains warm during this time.

From the dynamic systems perspective, the most advanced practitioners have created such a deep basin of attraction of mind through their use of PCTs that they able to use mind to control even their most subtle energies. In the processes of dying and even in death, mind is the attractor in phase space toward which all parameters are drawn.

6.10. Meditation Practices

Meditation practices are a vital part of ITB practice since it is claimed that once ignorance is eliminated *rigpa* is unobscured and suffering ceases. According to the ITB tradition, such practices affect especially the dying and after death processes. These developments are

[294] Ibid.36.

believed to occur, in part, as a result of phenomenological self-observation and meditation. What constitutes meditation can be understood by the Tibetan term for it which is *gom.* The translation of this term is “becoming familiar with”. The notion is that meditation is the practice of becoming familiar with one’s mind both in its unobscured and obscured state, especially in relation to the creation and maintenance of the belief in a permanent, independently existing Self.

The number of meditation techniques is vast but can be subdivided into two categories, analytical and phenomenological. Analytical meditation involves practices of considering a concept from many different angles, a form of critical reflection. It requires directed thinking but also involves periods where one allows the mind to rest without thought. In this lull insight may arise. Analytic meditation may be used, for example, to dissolve one’s grasping at a permanently abiding Self.

Phenomenological meditation may encompass many different types of practices with different goals and effects, for example, practices where one directs attention and concentrates on an object such as the breath, where one identifies with the “wisdom mind” of an enlightened real or mythical being (in order to recognize one’s inseparable connection with one’s own wisdom mind), where one mentally takes on the suffering of others (*tonglen*), where one abides in pure, nondual awareness (*Dzogchen*) or where one engages in a variety of meditation practices related to death and dying.

According to the *Dzogchen* teachings, the main purpose of meditation is to experience and stabilise *rigpa.* According to ITB, when on stabilizes the mind in its natural state, there is no difference between this state and the state of mind one experiences after death, (referred to as the ‘clear light state of mind)’. If one can stabilize this state while alive, then it is believed that one may control the experience of death and dying. It is claimed that this is a mental process which can be cultivated. This is discussed further in chapter 7.

6.11. Dynamic Systems Analysis of Mind and Meditation

The ITB tripartite classification of mind---gross, subtle and very subtle--- and the claim that meditation enables the practitioner to become aware of the more subtle aspects of mind, suggests that meditation (see section 6.10) is a parameter that affects the quality of awareness. Initially, the practitioner is only aware of the gross manifestation of mind because the basins of attraction of awareness and meditation are shallow. The depth of the meditation basin correlates with the depth of the awareness basin. As the practitioner develops the practice of meditation (the basin of meditation deepens), the trajectory of awareness in phase space moves toward the attractors of subtle and very subtle mind. A point on the trajectory represents the practitioner's awareness of mind at a moment in time.

6.12. Death and Dying in Indo-Tibetan Buddhism

Death and dying plays a vital role in Indo-Tibetan Buddhism and accordingly must be discussed here. However, it will make an appearance again in chapter seven (section 7.4), when I discuss death and dying from a comparative perspective.

According to ITB teachings, when the mind is no longer encumbered by the body, the possibility of liberation is greatest. But without the stability of body the mind is also most strongly subject to the obscuring mental tendencies to which one was habituated while alive. Thus, if one was not successful in freeing the mind while alive, then the mind would likely be overcome by those habitual mental tendencies at the time of death and the opportunity for liberation would be lost. However, if one was successful in training the mind and controlling or eliminating negative mental tendencies, then one might experience the continuity of consciousness throughout the dying process and into death. Then, it is believed, one may either choose the conditions of the next birth or choose not to be reborn at all. Since the elimination of suffering through liberation is the desiderata, practitioners seek to be prepared when their death occurs. The first requirement is to stabilize the mind. Mindfulness meditation designed for this purpose. The fruit of this practice is referred to as calm abiding or quiescence (Skt *śamatha*). When one achieves the desired stability and control of mind, then one is able to remain focused on the object of one's attention without lapse for an extended period of time. This degree of stability is required during the dying process when the "winds of emotion" blow most strongly. Mindfulness meditation serves other purposes as well. For instance, the technique is used to observe the everchanging flow of body, speech and mind. This process is thought to loosen and perhaps eliminate the attachment to the false conception of Self. Thus, ITB makes the connection between the concept of no- Self, stability and control of mind and liberation.

Visualization, another PCT, is also integral to ITB meditation, for example, visualizing in elaborate detail the figure of a *buddha* or *bodhisattva* to which one is particularly drawn. The idea is to be able to mentally recreate the figure of the being and ultimately to allow oneself to mentally merge with it. To do this successfully, one needs quite a bit of mental stability and control. The understanding is that one is identifying with the enlightened qualities of the visualized being and thereby recognizing that in essence, one's enlightened mind is no different from that of the visualised being. This type of meditation is frequently utilized when one is dying. In the process of identifying with the already enlightened mind, one is no longer clinging to the impermanent, limited and mistaken sense of Self.

The most advanced form of meditation in the Nyingma tradition of ITB is referred to as *Dzogchen*. In this practice, one dispenses with technique altogether and simply abides in, what the tradition believes to be, the "natural state of the mind", *rigpa*, free of emotion, attachment and subject-object duality. It is the state of pure awareness, the state in which one should abide, if able, at the time of death. The highest attainment of the ITB practitioner is to stabilize the mind in pure awareness while alive. In the stabilization of pure awareness, it is believed that the practitioner has conquered clinging, attachment and ignorance based on the false belief in Self.

All meditation techniques and indeed all practice techniques are designed either directly or indirectly to transform the mind from a state of ignorance to enlightenment. All phenomena in the world including mental content are used to transcend these phenomena by realizing their relative (not ultimate) reality.

The process of dying is referred to in ITB as "the painful *bardo* of dying". *Bardo* is a Tibetan term which literally translates as "intermediate state".

One who, during his lifetime, has stabilized *rigpa* can continue to abide in the mind of the clear light of death and it is traditional to remain in this state for a period of about three days. If one is successful, it is said that during this time the heart remains warm and the body does not decay. So according to ITB, there is a period during which mind functions free of the physical body but nevertheless has a "downward" effect.

It is critical for the purpose of this dissertation to recognize that the ITB description of death challenges the enactivist mind-life continuity thesis. But enactivism was based on the work of biologists Maturana and Varela) and later Thompson) whose initial goal was to identify necessary and sufficient conditions for the determination of life. They were not concerned with death and enactivism ever since has not attempted to tackle philosophical issues concerned with dying and death. I maintain that the dying process can be theorized as the counterpoint to autopoiesis. However, the challenge is to consider the capacities of mind during the dying process and controversially, even after death.

For the dying ITB practitioner, a range of meditations may be engaged in to achieve liberation depending on one's level of realization. The practitioner who, during his lifetime, has stabilized *rigpa*, continues to abide in it throughout the dissolution process and thereby obtains final liberation. For the practitioner who has not stabilized *rigpa*, during the dissolution process, he may practice *Guru Yoga*. This is the practice of visualizing and uniting with a deity or *Buddha* (*yidam*) which represents wisdom and compassion. As the outer dissolution occurs, one might visualize this being in the various subtle energy centres and finally unite with it. The *yidam* is understood to be a representation of one's enlightened mind.

Through the practice of repeatedly visualizing the *yidam* and uniting with it while alive, one comes to realize that the enlightened mind of the *yidam* and one's own mind are not separate.

For a period of forty-nine days after death, the practitioner may be guided through the *bardo* of death and the *bardo* of rebirth by recitation of the *Bardo Thodol* more commonly known as the *Tibetan Book of the Dead* by any living person. The book describes the experiences one is likely to encounter in these *bardos* and provides guidance to liberation. It is understood that all one's *bardo* experiences are solely the manifestation of the contents, proclivities and conditioning of one's conventional mind from all past lives. One gains liberation by realizing this. The purpose of reciting the content of the book is to guide the deceased through the *bardos*. In other words, there is the belief that communication with the mind of the deceased is possible.

In dynamic systems terms, the transformation of mind is represented by a trajectory through phase space in which practices and concepts constitute parameters, some determining deeper basins than others all of which are in flux. Impermanence may be conceived as a precondition of all phase portraits since a trajectory is a time-dependent process in phase space, neither stable nor permanent. Both serve multiple purposes, among the most important is loosening one's grasping and attachment to relative reality and opening to 'ultimate reality'. The process of dying likewise may also be considered a process represented by a trajectory through phase space in which these two concepts, among others, are strongly coupled. To the extent that one has succeeded in loosening one's grasping and attachment to relative reality and opening to 'ultimate reality, one may be well prepared for the experience of dying. Death is not conceived as a state but rather a continual process the experience of which may be influenced by the quality of the practitioner's practice. The trajectory of that process is conceived to continue beyond the death of the physical body.

In contrast, enactivism, based as it is on naturalism, conceives death as a state determined or declared by medical science. There is now a recognition that biological death is a process in which structure and functions cease or deteriorate at different times. The dying process may be conceived in DST terms as a trajectory through phase space amenable to treatment by medical science perhaps but not to the dying individual. And death is the end-point of that trajectory with the deepest basin, appoint attractor, the most stable point.

6.13. Indo-Tibetan Buddhism: Case study in the Eco-Dynamic Paradigm

The hyphen in eco-dynamic paradigm indicates that these two concepts, ecology and dynamic systems are enmeshed, not separate, but rather a functional whole. 'Eco'- is used to refer, by analogy, to an ecosystem in which "a community of organisms and their physical environment interact as an ecological unit."[295] These organisms are bound into a functional

[295] Capra, F. and Luisi, P.L. (2014). *The systems view of life: A unifying vision*. Cambridge: Cambridge University Press.

whole by their mutual relationships. The concepts, practices, ethics, etc of ITB analogously are ecologically bound together as a functional whole to create a Buddhist ecology of mind in just the same way that chapters 1--5 showed the same for enactivist accounts of mind. An ecosystem is a network of interdependent organisms which adjusts its memberships as conditions change to maintain a homeostatic balance. A change in any one organism triggers adjusting changes in others. Analogously, the various components of ITB constitute a functional dynamic network, a system, in which the basins of the various attractors may shift depending on circumstances.

In the next chapter, I discuss and compare western and ITB views of death and dying and how, in each tradition they may be manipulated by ACTs and PCTs respectively. The point is to consider how the eco-dynamic paradigm might deal with the issue of death in light of its recognition that the ITB perspective on mind has something valuable to contribute to the scientific understanding.

Chapter 7

Death: A Challenge for Enactivism?

"At this time, when the bardo of death appears to you,
Abandon attraction, attachment and fixation to all.
Enter into the nature of the clear oral instructions without distraction.
Transfer into the unborn space of Self-arising awareness."[296]

7.0. Introduction

The quotation above gives instruction to the ITB practitioner as the process of dying unfolds. The practitioner is admonished to not cling to anything that would stand in the way of self-liberation. Having accomplished calm abiding (see section 6.11.), the practitioner is advised to remain attentive and undistracted as the dying process progresses. The last sentence might seem puzzling. What is to be transferred and where is the transfer to? What does "self-arising awareness" refer to? The essence of skilful ITB death practice is the transfer of consciousness from life into pure, unembodied awareness. The claim is that if one can do this successfully, there is no *bardo* (section 6.11.) between death and rebirth. The quote provides an ontology of mind distinct from enactivism because according to ITB, the most subtle manifestation of mind exists independent of the body. By contrast, despite the apparent difference in this chapter, the medical scientific and ITB conceptions of mind are brought together with the purpose of examining what each may offer the other. It will become clear in the course of this chapter how different the ITB perspective on death is from that of western medical science. The sceptic might therefore ask what is to be gained by a comparison of two such different understandings. The sceptic might further argue that the goal of each is completely different and therefore comparison is problematic. The goal of ITB is soteriological; it is believed that the process of dying with full awareness intact offers the practitioner the opportunity of liberation. Therefore, the ultimate task of the practitioner is to master the mind in the process of dying so that one can use awareness to self-liberate. On the other hand, the goal of western medicine is to stave off death as long

[296] Ponlop, Dzogchen (2008). 120.

as possible. Thus, how to determine when death has occurred and how to reverse the process is increasingly important as the means to achieve this end advances. But my view is that the mind may play a role in both ITB and western medicine that may deeply inform (and challenge) the other perspective, with the result that each may have a more well-rounded ontology of death and dying.

As will become obvious below, a cross-cultural comparison will demonstrate that the understanding, criteria, and management of death and dying is relative to time, place and the means to identify it. There is no immutable boundary between life and death. Rather, the boundary is culturally identified and subject to revision. Nevertheless, ITB and western medical science each may offer the other insights that are useful. For example, ITB phenomenological cognitive technologies (PCTs) may shed light on the ability of those dying to influence the experience of death, and this in turn may shed light on the nature of the mind.

It is in dying and death that two paradigms with respect to the nature of the mind I have referred to in previous chapters, namely ITB and enactivism (in agreement with western medical science), come into sharpest contrast. As discussed, western medical science, as commonly understood, claims that when one dies, mind too ceases. By contrast, ITB claims that at physical death, mind continues to abide[297], for the nature of the mind is in essence, either "very subtle" or "non-physical" (depending upon the translation of the word "rigpa"). These two translations are not synonymous, for 'very subtle' could be interpreted to mean "physical although perhaps beyond the current ability of instrumentation to detect or measure". According to this interpretation, it is possible that there is not the gulf of misunderstanding, with regard to the nature of the mind, as is usually conceived. Rather, one might argue that both camps agree that mind is not immaterial, but they disagree on the nature of the substance and function of mind. Here we get into trouble in trying to pin down the nature of the disagreement because Indo-Tibetan Buddhists disagree on the question of whether *rigpa* is material.

And indeed, a common ITB position is to say only what mind isn't rather than what mind is. There are instances, for example dying and death, in which mind is implicitly treated as very subtle rather than immaterial. For example, descriptions of how one should position the

[297] The term "abide" in this context refers to the continued existence of mind even after the death of the body.

physical body in the dying process suggests that position matters. But why should position matter if what is departing the body is immaterial? And in death, it is believed that moving the body disturbs the clear mind state of the practitioner. But again, why would movement disturb an immaterial mind? Indo-Tibetan Buddhists might claim that science has not yet discovered and perhaps cannot discover the most subtle nature of mind as it is beyond the bounds of physicality. One problem in the cross-cultural dialogue is that the nature of the physical has not been a topic of discussion to date. Is the movement of energies, (as discussed below in section 7.4) the movement of something physical? If mind can be said to abide in any sense after death, what, if anything, is the substrate? Much clarity would be gained by a cross-cultural discussion of the topic and this discussion can take place because the eco-dynamic paradigm developed here is the framework for it.

In any case, there is substantial disagreement between ITB and contemporary science in describing what happens during and after physical death. In making a case for the eco-dynamic paradigm, on which I will elaborate in the next and final chapter, thanatology plays a significant role. Medical science recently has convincingly made the case, in agreement with ITB, that death is not a state and does not occur at a fixed point (although it is usually treated in that manner clinically). Rather, it is a process subject to intervention and reversal as science learns more about how the body functions and ceases to function in the dying process and how to counteract this process through the utilization of technology (see section 5.6. on negligible senescence) and this brings Western medical science closer to ITB.

One issue of philosophical import is the distinction between criteria of death and concepts of death. I will argue that criteria of death should follow from a conception of what constitutes death. And what constitutes death turns on what constitutes life. Science and ITB differ as to what constitutes life and therefore what constitutes death. As discussed in chapter two, one conception of life relies on autopoiesis, the ability of a system to maintain self-organization far from thermodynamic equilibrium. According to this concept, a system no longer able to sustain itself through self-organization eventually arrives at thermodynamic equilibrium, that is, death. In contemporary society, this is a purely medical determination. The ability to maintain self-organization depends on the function of crucial bodily systems, according to one set of criteria, whole brain, or lung, and heart functions.[298] But suppose that a person no longer maintains self-organization but nevertheless does not move toward thermodynamic equilibrium. In other words, there is no observable metabolic or other systemic function and it appears that physical deterioration does not occur in the normal manner; and medical criteria of death are met. Is the person dead? It might seem that this person hovers between life and death yet cannot be classified as either. This has in fact been demonstrated in cases where an individual has drowned in cold water. Heart and lung function may stop, brain activity might cease yet cell apoptosis (cell death) is retarded due to the lowered body temperature. There have been cases in which such individuals have been resuscitated after extended time periods and normal bodily function has resumed unimpaired.[299] Were they dead and brought back to life or were they only near death, hovering between the two? And if near death, what additional criterion, if any, must be met to classify such individuals as dead? One common criterion is "irreversible cessation" of brain, or lung and heart function. But if artefactual technology is continuously developing to advance the ability to reverse the cessation of these vital functions, does this alter the concept of death? I think not. It only alters the determination of irreversibility as technology develops to alter the fact of irreversibility. Medicine does not provide a concept of death but rather criteria for its determination. Philosophically however, it is unsatisfactory to hinge a definition of death (in which death is conceived as a state) on the criterion of irreversibility[300] (which is process driven) because this depends, in part, on what equipment is available to a hospital to resuscitate the patient. This leads to the seemingly bizarre consequence that one would be considered dead or not depending on one's location. Yet, from a pragmatic perspective, this is in fact the case.[301] And this pragmatic stance is instantiated in Uniform Determination of Death Act(UDDA).[302] Also, irreversible cessation of vital functions conflates the criteria of death with the conceptual definition of death. This creates moral and philosophical problems as discussed below.

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[298] Uniform Determination of Death Act agreed by Harvard physicians and enacted by the majority of American States.

[299] Parnia, S. (2013). *Erasing death: The science that is rewriting the boundaries between life and death.* New York: Harper Collins.

[300] Feldman too finds the criterion of irreversibility problematic but for different reasons. Feldman, F. (1992). The enigma of death. 56-71 in Feldman, F. *Confrontations with the reaper.* New York: Oxford University Press.

[301] Parnia S.(2013).; Parnia, S. (2014). *The Lazarus effect.* London: Ryder.

[302] Uniform Determination of Death Act, http://www.lchc.ucsd.edu/cogn_150/Readings/death_act.pdf.

Contrast this with the ITB concept of death in which death is not constituted by physical death but by the passing (into the *bardo*) of one's mental continuum (*rigpa*). Death is conceived as a two-part process, the first part constituted by dissolution of the subtle underlying substrates of physicality, the second constituted by the dissolution of the gross and subtle aspects of mind and the liberation of the very subtle aspect of mind. Death is deemed to occur at the conclusion of the second dissolution. In the ITB conception of death, the definition and criteria of death, both philosophically and pragmatically, are consistent. Technology plays a significant role in both scientific and ITB conception of death. However, only in ITB does mind, as the instrument of phenomenological cognitive technology, play an active, central role in the dying process (See chapters 5and 6 on PCT). These two concepts of death will be discussed in more detail below.

In this chapter, I will examine death from the medical and ITB perspectives. The role of technology *vis a vis* death will also be considered. Although the focus here is on the mind as the process of dying proceeds, necessarily some attention will be paid to bodily functions, for body and mind are continuous. From both the ITB and medical perspectives, it will become clear that dying is a complex, dynamic process composed of multiple attractors with basins each of which may vary in depth in relation to the dynamics of the others. Here I focus on both artefactual cognitive and phenomenological cognitive technologies as a means of affecting both the duration and the quality of the dying process. I take it as given that the belief that Buddhist phenomenological cognitive technology can alter the dying process in the manner described by Indo-Tibetan Buddhists is controversial from the perspective of medical science. I do not advocate either position. Rather, my purpose is to set the two perspectives side by side as a means of considering what each might gain from the other and to highlight their similarities and points of contact and I will draw on this material in the final chapter in formulating the eco-dynamic paradigm.

7.1. Anomalous Cases of Death from the Perspective of Medical Science

According to medical science, it is axiomatic that the brain modulates consciousness and, in whole or in part, a variety of other functions such as respiration, cardiac function, thermoregulation, cognition, memory, emotion and the like. This section presents counterfactual data. The purpose is to challenge medical science to either explain this data or expand its theoretical framework.

Many life functions are necessarily correlated (in part) with neural activity as demonstrated by such equipment as the electroencephalograph, functional magnetic resonance imagery, and the like. According to this view, the failure of instrumentation to register neural oscillations may provide evidence of lack of whole brain function. But this view has recently come into question. Sam Parnia, a critical care and resuscitation physician, has led a landmark research study, 'AWARE' (Awareness during Resuscitation). He reports that:

> "The evidence so far seems to suggest that the occurrence of consciousness in relation to cardiac arrest is somewhat of a scientific paradox that cannot easily be explained using our current neuroscientific models. This is because consciousness (or the soul) seems to continue to exist and function during cardiac arrest and death, as evidenced by the ability of people to have well-structured thought processes, complete with reasoning and memory recall, when the brain circuits that modulate consciousness are down and consciousness appears lost to the outside world."[303]

Parnia is referring to the fact that some people who have had a near death experience claim to have had mental experience during this time despite lack of evidence of brain function or consciousness. A key question is whether anomalous cases of this sort can be explained by current or modified neuroscientific models or whether new (or perhaps supplementary)neuroscientific models are needed to explain such phenomena. Clearly then research into anomalous cases is important, for these may help in understanding more fully the functions and capacities of the brain and its relationship with mind. For example, Evan Thompson cites several examples of ITB practitioners whose highly developed meditation and mental skills might have played a role in delaying physical deterioration after biological death. For example, Thompson described the case of the Tibetan lama Jampa Thupten Tulku Rinpoche who died on May 24, 2011.[304] He was reported to remain, for 18 days, in *thukdam,* a Tibetan death meditation practice in which one is thought to remain in the clear light of pure awareness (ground luminosity) after physical death as understood by medical

[303] Parnia, S. (2014). 225.
[304] Thompson, E. (2015). *Waking, dreaming, being.* New York: Columbia University Press 293-295.

science. During this period, it is said that his body did not noticeably decompose, his skin remained supple, and there was no bodily odour. The story of his thukdam was reported on New Zealand television.[305] In that report, a forensic pathologist, Dr. John Rutherford stated that bodies may remain in a relatively composed and stable state under certain conditions such as low ambient temperature and humidity and the intestine being empty of organisms which would spread throughout the body after death and cause putrification and decomposition. Such conditions occurred in this case as Jampa Thupten Tulku Rinpoche who was kept in a cool, dry room and who died of cancer, a wasting disease. It's possible that the medical model is successful in explaining this case. If so, this case would be unusual but not anomalous.

A truly anomalous case is that of Lobsang Nyima who resided in Drepung Loseling Monastery in Mundgod, South India.[306] He died September 14, 2008 and was reported to remain *in thukdam* for 18 days. Again, there was no noticeable decay, or odour during this period even though Mundgod is relatively warm and humid so some of the conditions of preservation were not met. Richard Davidson and other scientists had brought a thermal camera and an EEG/EKG respiration monitor to study the *thukdam* phenomenon. Thompson reported that the results of the study were not yet complete at the time of the publication of his book in 2015.

My purpose in raising these cases is not to defend a particular explanation. Rather, I present what might appear to be anomalous cases to highlight, that in my view, thukdam is worthy of further research.

Thompson also reported on a meeting he attended at the Center for Investigating Healthy Minds at the University of Wisconsin-Madison. Davidson is founder and Director of the Center. A group of experts in a variety of scientific, medical and other disciplines were convened to discuss the best ways to study and understand thukdam. A forensic pathologist, Vincent Tranchida and a forensic anthropologist, Daniel Wescott, specialists in scientifically examining dead bodies, attended the meeting. They reported that body decomposition may be delayed in cold and dry humidity environments such as was experienced by Jampa Thupten Tulku Rinpoche. Also attending the meeting were experts

[305] Death meditation. YouTube video: https://www.youtube.com/watch?v=gtA7BVLD5l8.
[306] Thompson, Evan (2015). 296-299.

on Tibetan Buddhist meditation who described deep meditative states in which observable breathing appears to be suspended. Mark Roth, an expert in the molecular biology of suspended animation, wondered whether this practice, in which the demand for oxygen was reduced, was able to slow or even stop metabolic activity. If so, he conjectured that the practice might alter the physiology of dying and death by affecting the practitioner's metabolic rate.[307]

Supposing all this is correct, one might wonder if oxygen consumption is reduced or even eliminated, metabolic activity is slowed or even stopped, heart and brain function is not detectable, and no observable physical deterioration has occurred and it is not known whether or not these conditions are reversible, is the person dead or alive? In this case, a new category hovering between life and death might need to be established if they appear to meet the criteria of whole brain or cardiopulmonary death, although anomalously. One is not alive if whole brain and cardiopulmonary functions does not exist. Yet intuitively it would seem that one is not dead if decomposition is not occurring and it is unknown whether they will resume life functions. In this case, the criteria of death might need to be revised. Self-organization might be a better criterion of life and death in such cases. The application of this criterion would suggest more clearly than the whole brain-cardiopulmonary criteria whether or not the person is alive.

There is, however, a third possibility. Anomalous cases such as this could be thought to constitute an exception to the brain death criterion as is currently the case in hypothermia and certain drug-induced states. In such cases, an extended period of observation is required, and resuscitation is attempted before death is pronounced. At the very least, anomalous cases push the boundaries of current scientific understanding and require research and philosophical consideration to understand more deeply, what constitutes life and death. This is the meat and bones of the eco-dynamic paradigm. Just as enactivism requires the amalgamation of neuroscientific and phenomenological technologies to study living consciousness, so too the eco-dynamic paradigm requires the utilization of artefactual and phenomenological cognitive technologies to study the mind in death and life. But unlike enactivism, the eco-dynamic paradigm does not assume, *ab initio*, a conservative interpretation of naturalism. I discuss naturalism in more detail in chapter eight.

[307] Ibid. 297-298.

Despite different criteria of what constitutes death and despite different beliefs of what happens to the mind at the time of death, both ITB and critical care medicine have reported apparent mental function during the near-death state. In the case of ITB, there is a well-established understanding that *rigpa* and mental experience continue after biological death. According to ITB, the nature of the mental experience during and after death depends upon one's mental training while alive. And if there is little or no such training then one's mental experience during this period depends upon one's mental state during and previous to the time of death and also upon one's cultural context. In the case of medical science, evidence from the AWARE study, the writings of Parnia and others raise the question of how to understand what appears to be the continuity of mental experience when it seems that there is no evidence of brain function. Can ITB concepts and phenomenological cognitive technology (PCT) help to advance the biomedical model of what happens to the mind in the processes of death and dying? And can medical science help to explain the mental and biological phenomena experienced by advanced ITB practitioners during these processes? Very little cross-cultural research has been done to date which can shed light on these topics. As noted, Davidson has attempted to gather 'objective' data but, as far as I can tell, he was not successful. Most reports of mental experience near-death is anecdotal. While anecdotal information on near-death experience is necessary, phenomenological data is insufficient by itself for a comprehensive understanding of the experience. Likewise, scientific data alone is necessary but insufficient in itself for a phenomenological understanding of near death. Clearly then cross-cultural, neurophenomenological studies are necessary to provide a more comprehensive understanding of the subject. Accordingly, I shall compare and contrast death and the dying process cross-culturally. I will begin with consideration of the dying process from the perspective of medical science.

7.2. Definition of Death in the U.S.A.

It is telling both culturally and conceptually that in the United States, a team of doctors from Harvard University was convened to provide a working definition of death. It is significant culturally because death is conceived as akin to disease, thus, the province of medicine. Yet, it is the one experience each of us is guaranteed to undergo. In the United

States, when one is near death, they are commonly rushed to hospital and significant efforts are often made, sometimes at great expense, to preserve or extend their life. Failure to act in such a manner, in the absence of an advance care directive or living will, may be considered grounds for malpractice and may be legally actionable. Though unstated, death would appear to constitute failure on the part of the medical establishment to preserve life. Typically, spiritual and moral considerations are not the primary consideration.

Medical science conceives death as the termination of life which is measured by biological function. While evidence of biological function is necessary, in the absence of an understanding of what constitutes death, it is unclear that biological function alone is sufficient.

In the United States, the definition of brain death as irreversible coma was recommended by an *ad hoc* committee of the Harvard Medical School in 1968. The *ad hoc* committee was convened because then recent developments in medical technology created a quandary as to criteria of death. Previously, criteria of death had been the cessation of vital lung and heart functions. But when mechanical ventilation became widely available, lung function could be artificially maintained[308]. And heart function could be restarted by cardiopulmonary resuscitation (CPR)[309] and electrical stimulation[310]. The question then was whether an individual was alive or dead when vital functions were only maintained by artificial means. The development of the possibility of heart transplantation compounded this, giving rise to questions about the status of both the donor and the recipient, with all the consequent ethical implications. Criteria were revised to take into account advances in medical science and technology.

In their report, the *ad hoc* committee explicitly stated that their primary purpose was to define irreversible coma as the new criterion for death.[311] The committee recognized that coma had many causes but stated that their concern was with situations in which there was

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[308] Medical ventilation: http://www.atsjournals.org/doi/full/10.1164/rccm.201503-0421PP#readcube-epdf. Positive pressure mechanical ventilation was developed in 1950's,

[309]Cardiopulmonary resuscitation: http://cpr.heart.org/AHAECC/CPRAndECC/AboutCPRFirstAid/HistoryofCPR/UCM_475751_History-of-CPR.jsp. Cardiopulmonary resuscitation was developed in 1960,

[310] External electrical countershock was developed by Paul Zoll from 1956 onward to restart the heart after cardiac arrest or during atrial fibrillation.

[311] Ad hoc Committee of the Harvard Medical School (5 Aug 1968). A definition of irreversible coma: Report of the ad hoc committee of the Harvard Medical School to examine the definition of brain death. *JAMA*. 205 (6). 337-340.

no discernible central nervous system (CNS) function. They believed that if an adequate definition could be provided, this would prepare for clarity with regard to "moral, ethical, religious, and legal issues".[312] Perhaps because the biological criteria of death had previously been utilized and death was assumed to be the cessation of biological function, it seemed obvious to the *ad hoc* Committee that such criteria should be extended. Here the term "criteria" when used in connection with death refers to features, which, when present, are sufficient to deem the person dead. In the U.S.A. these criteria are statutorily defined and codified into a UDDA to be adopted by the states. These criteria have gained wide recognition worldwide. In the United States, the legal criteria of death are the whole brain-cardiopulmonary standard. According to these criteria, death ensues when the whole brain---lower brain and higher brain--- irreversibly ceases to function; that is, the brainstem which governs autonomic functions, the cerebrum which, in part, governs conscious awareness and the cerebellum governing voluntary muscle movement. This standard is generally associated with the cardiopulmonary standard according to which death ensues when lung and heart functions irreversibly terminate. The Act incorporates both as the legal standard of death both the cardiopulmonary standard and the whole brain standard in the disjunctive. That is, death is constituted when either standard is met. The Uniform Act states, in part:

> "Determination of Death. An individual who has sustained either (1) irreversible cessation of circulatory or respiratory functions or (2) irreversible cessation of all functions of the entire brain, including the brain stem is dead. A determination of death must be made in accordance with accepted medical standards."[313]

However, these criteria have been and continue to be challenged by a vocal minority. Some of these concerns were voiced in a white paper disseminated by the President's Council on Bioethics.[314] A more nuanced approach to the concerns was taken by the 18

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[312] Ibid. 337. Pope Pius xii had stated in 1957 that physicians were not obliged to provide "extraordinary" treatment in cases deemed to be hopeless. Clearly, determinations regarding death were ceded to the medical establishment. De Georgia, M.A. (2014). History of brain death as death: 1968 to the present. *Journal of Critical Care* 29, www.sciencedirect.com/science/article/pii/S0883944114001531?via%3Dihub.

[313] Uniform Determination of Death Act, http://www.lchc.ucsd.edu/cogn_150/Readings/death_act.pdf.
[314] The President's Council on Bioethics (Dec 2008). Controversies in the determination of death: a white paper by the president's council on bioethics, https://repository.library.georgetown.edu/handle/10822/559343.

members of the Council which was composed of a Christian ethicist, professors of ethics, morality and law, neurologists, neuroscientists and a professor of metaphysics and moral philosophy. The Council characterized the philosophical debate as central to their inquiry and characterized the concern as follows: whether there is or is not sound biological justification for the neurological standard. The Council briefly considered and dismissed a third position, namely that there can be two deaths: the death of the (cognitive) person and the death of the human organism. Their basis for rejection of this view was that the cognitive aspect was subjective and could only be imputed indirectly by biological function. Clearly, this basis is controversial. In its defence, one might argue that since the mental supervenes on the physical, then the decision of the Counsel was justified. On the other hand, it might be argued that we don't know the extent to which mind supervenes only on brain function and if minimal subjectivity is possible without brain function, then caution should be the more prudent approach. The Council did not have a unanimous view that cognition was purely biological but from their rejection of 'two deaths' possibility, it is apparent that they agreed that cognition supervened on the biological organism.

As to the view that there was not sound biological justification for the neurological standard, the Council cited a portion of the essay by the philosopher Hans Jonas:

> "We do not know with certainty the borderline between life and death, and a definition cannot substitute for knowledge. Moreover, we have sufficient grounds for suspecting that the artificially supported condition of the comatose patient may still be one of life, however reduced—i.e., for doubting that, even with the brain function gone, he is completely dead. In this state of marginal ignorance and doubt the only course to take is to lean over backward toward the side of possible life."[315]

Jonas makes the point that any set of criteria of death doesn't provide definitive knowledge of what constitutes death. While the desire for an all-encompassing universal definition of an abstract concept such as death may seem to be desirable, in practice such a definition may be elusive. I believe that death is an abstract term which is constitutively context dependent; it needs to be determined in a particular situation based upon a number of factors such as cause of death, availability of technology and personnel able to

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[315] Ibid.53 citing Jonas, H. (1974). *Against the stream philosophical essays: From ancient creed to technological man.* Englewood Cliffs, NJ: Prentice-Hall. 138.

reverse the cause of death and ability to resuscitate the individual and perhaps other factors as well. All factors are attractors amenable to accommodation by Dynamic Systems Theory which will be discussed below.

The force of Jonas' argument is strong. I have argued in chapter two that self-organization is a hallmark of living beings. If we can show either that self-organization continues or that deterioration of self-organization does not occur when the brain, heart and lungs cease to function, that would provide a forceful demonstration that, at least in some cases, the whole brain-cardiopulmonary criteria are insufficient. Such evidence (as regards brain function) was provided by Shewmon who cited a list of integrated somatic functions that may continue even during brain death. And he also cited over 100 cases of individuals who have experienced such.[316] In the abstract to his article entitled 'The brain and somatic integration', Shewmon states:

> "The mainstream rationale for equating ``brain death'' (BD) with death is that the brain confers integrative unity upon the body, transforming it from a mere collection of organs and tissues to an ``organism as a whole.'' In support of this conclusion, the impressive list of the brain's myriad integrative functions is often cited. Upon closer examination, and after operational definition of terms, however, one discovers that most integrative functions of the brain are actually not somatically integrating, and, conversely, most integrative functions of the body are not brain-mediated. *With respect to organism-level vitality, the brain's role is more modulatory than constitutive*, enhancing the quality and survival potential of a presupposedly living organism. *Integrative unity of a complex organism is an inherently nonlocalizable, holistic feature involving the mutual interaction among all the parts, not a top-down coordination imposed by one part upon a passive multiplicity of other parts.* Loss of somatic integrative unity is not a physiologically tenable rationale for equating BD with death of the organism as a whole". [317](italics added).

Humans are complex organisms composed of multiple somatic scales-- cells, tissues, organs, and organ systems-- integrated for optimal function. The brain plays a significant

[316] Ibid 55-57 citing Shewmon, D.A. (1998). Chronic brain death: Meta-analysis and conceptual consequences. *Neurology* (51)(6). 1538-45;
Shewmon,D.A. (2001). The brain and somatic integration: Insights into the standard biological rationale for equating brain death with death. ***Journal of Medicine and Philosophy,*** (26)(5) 457–478, https://doi.org/10.1076/jmep.26.5.457.3000.
[317] Shewmon (2001) 457.

coordinating role, of course, but so do all the scales of human structure and function, some mediated by the brain and some not so mediated.

Shewmon is correct that the brain's role in organismic vitality is modulatory rather than constitutive. This is an important point, for enactivism also posits that the brain modulates (but is not constitutive of) cognition.

Shewmon is also correct that integrative unity of a complex organism consists of the mutual interaction of all its parts. He draws on the language and concepts of complex dynamic systems theory and this is extremely significant. As established in chapter two, reciprocal, not top down causality, is the means by which complex organisms integrate functions.

In chapter two, I described how dynamic systems theory provides a theoretical framework for the concept of life and mind. Now I assert that philosophically, self-organization is a better criterion for life and death than the predominant view of life and death in biological and medical science.

The predominant view of life consists of a non-exclusive list of features and characteristics as mentioned in Chapter two. A conceptual definition is avoided in favour of a list of features. Likewise, death is determined by a set of criteria

A hint as to the problematic nature of criteria-based definitions of death is provided in the report of the *ad hoc* committee. Their report states that in the case of death accompanied by drug intoxication or hypothermia the body should be monitored and observed for 24 hours or longer before a final determination of death is made.[318] This is because it has been empirically demonstrated that these two conditions may produce signs which mimic the symptoms of brain death yet do not constitute death since the person might still recover. And in such cases, there is anecdotal evidence of cognitive function in the near death state. But suppose there are other circumstances which also mimic the signs of brain death such as *thukdam* (e.g. flatline EEG) and which have not yet been discovered by medical science.
In such cases, one may be prematurely declared dead even though there may be cognitive function.

[318] *Ad hoc* Committee of the Harvard Medical School 340.

The supposition of cognitive function in these circumstances is not merely speculative but may be buttressed by two separate bodies of information. In the case of apparent death due to hypothermia (either induced or natural), when the victim was brought back to life, at least in some cases, mental experience was described even in the absence of brain activity. This provides a hint that, as Shewmon argued, lack of brain activity, in itself, may not be constitutive of death but this data alone is insufficient. Alternate explanations for the claimed mental experience in the near-death state may be provided. For example, it is possible that mental experience commenced once the brain began to function, but the subject misconceived the timing of the experience. Alternatively, it is possible that the subject hallucinated the experience or had false memories in the process of resuscitation.

A second body of evidence touched on above and to be described in some detail (infra) is provided by advanced ITB meditators whose bodies display no visible signs of deterioration for extended periods of time during *thukdam* when there might be no brain function. In the ITB tradition, the body of the deceased is left undisturbed until physical signs of deterioration manifest. The claim is that physical death is not the final stage of death. According to this view, rigpa may play a role in maintaining the physical integrity of the body sometimes for days after physical death has occurred. If this is so, then it would seem that self-organization and dissolution of self-organization are both in limbo. These two situations perhaps give substance to the words of Jonas as stated above.

But two objections might be raised to a criterion of death based upon deterioration of self-organization. First, organ transplantation would seriously be impacted particularly but not exclusively where the organ to be transplanted requires the donor to be "dead" (e.g. heart transplants) because dissolution of self-organization assures that death has not actually occurred until after the organs have ceased to be viable. So, if the criterion of death is dissolution of self-organization, then no organs can be transplanted from the dead. One consequence of such criterion would be the death of many potential recipients who otherwise might have lived had organs been available for transplantation. One response to this objection, of course, is based on ethical concerns; it should not be a human decision to weigh the value of one life over another even when the life of the potential donor is seriously diminished, and the life of the potential recipient is not. Of course, this issue is open to serious and prolonged debate.

The second objection is epistemological and is as follows: Even if the deterioration of self-organization criterion was adopted, it would still rely on a list of biological criteria because there might be no point at which it is obvious that some mental process (such as is claimed in the second dissolution for Indo-Tibetan Buddhists) was not taking place. It is an inference, based on lack of brain function, that there is no mental function. As such, it might be argued that this criterion is no better than the whole brain criterion. To examine this objection, it is necessary to examine the ITB practices associated with death and dying (7.4 below) to determine whether this objection has been successfully met.

7.3. Near-Death States in the AWARE Study

Throughout history there has been anecdotal evidence of individuals who have had near-death[319] experiences and have survived to tell of their experiences while "dead". Anecdotal evidence and more recently medical data poses a challenge for medical science to explain how claims of mental experience while apparently dead can occur in the absence of brain function.

Recently, medical science has been able to artificially create the conditions required to minimize cellular damage while one is in the near-death state, then, when possible, to repair the cause of apparent death and resuscitate the individual. For example, when the cause of apparent death is a heart attack due to arterial blockage, it is now possible to minimize cellular damage by cooling the body, providing artificial circulatory and pulmonary functions, surgically removing the coronary blockage and resuscitating the individual. Thus, resuscitation medicine, a subspecialty within the field of emergency medicine, has been born. Sam Parnia says:

> "Death is no longer a specific moment in time, such as when the heart stops beating, respiration ceases, and the brain no longer functions. That is, contrary to common understanding, death is not a moment in time. It's a process--a process that can be interrupted well after it has begun."[320]

[319] Parnia points out that he term "near death" is vague and ambiguous. and, it can only be applied after the fact if resuscitation is successful. He suggests rather that such a person is actually dead and is resuscitated. Parnia (2013) 24. But the term "death" is also problematic if the condition is reversible because the UDDA provides irreversibility as a criterion of death. Nevertheless, I will continue to use the term "near death" as it has entered the common vocabulary.

[320] Parnia, S. (2013). *Erasing death: The science of rewriting the boundaries between life and death.* New York: Harper Collins 20.

Parnia, like Shewmon, challenges the brain-based criteria of death. Since death is a process, the process of brain death can be interrupted if the technological means are available. And irreversibility can only be determined after the fact. (See section 5.6 in which negligible senescence is discussed).

The treatment and therefore determination of death as a practical matter may depend upon the equipment available to medical staff. If there is equipment available to monitor, stabilize and minimize neural and somatic cellular damage in the near-death state, then determination of death is a quite complex and prolonged process. Simpler, yet still medically sophisticated, the criterion of whole brain death only applies where brain activity can be monitored. The point is that as a practical matter, criteria of death are context-dependent.

When the most sophisticated stabilization and resuscitation equipment is not available to artificially minimize cellular damage, the criteria of death are the whole brain-cardiopulmonary standard. But what is the criterion of death when equipment is available to lower body temperature, sustain circulation and thus minimize cellular damage? In such a case, when there is no heart, brain or lung function, the person presumably would be considered dead by the standard criteria except if the cause of death (e.g. coronary thrombosis) can be reversed. Since the condition is reversible, they cannot be said to have been dead (notwithstanding the legal definition of death) even though brain, heart and lung function has ceased. But if this intervention fails, these criteria once again become the applicable standard. What is the victim's death status during the interval in which they have died and are in the process of being resuscitated?

Parnia's view is that the person is dead (not near-dead) once the criteria of death are met. And if they are resuscitated then they are brought back to life. And if, in the interval during death, mental activity truly is experienced, what can be said of the correlation between neural and cognitive function?

It is fair to say that the understanding of death is in flux and not well understood. It is possible that our understanding of what constitutes brain death may be flawed either because the instruments used to measure brain function are not sufficiently sensitive, because there is not a sufficient understanding of what constitutes brain function and therefore what constitutes brain death, or for a multiplicity of other reasons. Or it may be that, as ITB proposes, mental function, at least in some cases, is not supervenient on the brain. In light of our lack of knowledge about the essence of what constitutes death, we are faced with the dilemma as to how to delineate it. Should it be delineated epistemically, phenomenologically or otherwise? Yet nevertheless, it is necessary to press on with the current criteria even in the midst of this philosophically unsettling situation, at least in part, because organ transplantations from donors are based upon it.

Parnia has compiled stories of individuals who had undergone near-death experiences and been resuscitated. For our purposes, it is important to note that these individuals were thought to have no brain function during this period. One finding of the AWARE study was that some individuals who were resuscitated claimed to have had experiences of an "after-life". Some reported "witnessing" incidents that occurred in the operating theatre while they were apparently dead; incidents that were verified by people who were present at the time. Individuals have reported after-life experiences with a variety of common features, such as traveling through a tunnel, meeting beings, "hearing" instructions, experiencing "emotions", "reliving" experiences they had when alive, having memories of past experiences while in the near-death state, and perhaps most profoundly, experiencing a life-altering change of orientation upon being resuscitated. The sceptic might argue that these experiences were hallucinations and might seek to explain these so-called experiences as brain-based. These various reports would need to be categorized and individually examined as some presumably are neurologically explainable and others may not be. Still, it is believed that the brain ceases to function after being deprived of oxygen for about 10 seconds and if this is so, a brain-based explanation based on current understanding of brain function is elusive. Of course, the best course of research is to seek a physicalist explanation but to be open to other possibilities as well. This is the position of the eco-dynamic approach which would enthusiastically endorse the approach of Davidson who, as mentioned in section 7.1, arranged for instrumentation to be used to investigate *thukdam*. But additionally, I would suggest consultation with Vajrayana masters to determine what other means for investigating the *thukdam* phenomenon they would suggest.

7.4. Dying and Death Processes: the Indo-Tibetan Buddhist Perspective

Previously, I discussed death and dying in Indo Tibetan Buddhism (section 6.11). I revisit the topic in this section to compare the ITB conception of death and dying with that of Western medical science. I also previously discussed the Indo-Tibetan Buddhist conception of mind (section 6.8) and I revisit this topic too because mental training is requisite preparation for dying well.

It is chastening to compare the biological perspective on death with that of other societies, such as that of (the former) Tibet, if only to recognize that death is culturally defined, and that characterization provides significant insight into the worldview of a given society. Indo-Tibetan Buddhism thrived in a culture largely isolated from secular cultures and developed many PCTs designed to hone mental faculties in preparation for the dying process. What might the ability to train the mind in preparation for death help us to understand about the possible role of the mind in the process of death?

According to ITB, it is the state of one's habitual mental processes, one's psychological *karma*, that play a pivotal role in both life and death. Mind is within one's control if one masters it. ITB PCTs are designed for this purpose. While circumstances of one's life may not be completely within one's control, nevertheless one's response to these circumstances are. ITB prescribes practices to clear or purify and not repress negative emotions, psychological states, and habitual tendencies. Mastery ideally is thought to consist of the elimination of these "faults" or the ability to perceive their arising as "empty of inherent essence," yet nonetheless (mistakenly) presenting to the mind as negative states. According to ITB, any habitual mental states (including but not limited to negative states) not eliminated or controlled while alive are thought carried over into the *bardo* of death which then impacts one's experience in that *bardo*; habitual cognitive tendencies persist even after death. Nirvana ideally may be thought of as wiping clean those cognitive tendencies that otherwise would have been the cause of rebirth e.g. anger, hatred, jealousy, envy, attachment, ignorance, etc.

It is necessary to elaborate on the ITB conception of habitual cognitive tendencies to understand why they are considered a bar to stabilizing *rigpa* and why rigpa should be stabilised in preparation for death. Habitual cognitive tendencies, including (but not limited to) negative emotions, bias the manner in which perception and cognition function. It is thought that perception, cognition and the discursive mind are conditioned by concepts, language, and habitual cognitive tendencies. Stripping sense perception and cognition of the conditioning imposed by these elements is necessary to sustain the experience of non-dual awareness. It is thought that as one develops the ability to remain undistracted while perceiving raw sensory data, one is increasingly able to separate what is ultimately real from what is apparently or conventionally real (see section 6.7 on the two truths/realities). And as one is allows the arising of mental content to dissipate without ruminating, neither grasping nor attaching, it, one is increasingly able to separate what is ultimately real from what is apparently or conventionally real.

Language and concepts designate aspects of reality but cannot portray them directly, only "raw" experience can, provided the sense organs function well and cognition does not impose a barrier. Mindfulness, both in meditation and in everyday life, is an essential practice in the process of deconditioning. Through mindfulness meditation one becomes familiar with the ways in which the discursive mind imposes on one's experience based upon one's history and interpretation of it, habitual mental tendencies, conceptualization generally and lapses in awareness. And one becomes familiar with how this biasing impacts one's emotions and habitual cognitive tendencies, thus impairing the ability to perceive things as they are and to think clearly. Then courage and steadfast determination is required to deconstruct and divest attachment to these tendencies. Mental purification or deconditioning is but one tool thought to prepare the practitioner to face death.

The ITB stance on death may seem paradoxical. On the one hand, death is to be staved off as long as possible. One rationale for this position is metaphysical. The human realm (of the six possible realms of sentient existence) is said to be the most precious, as it is the only one in which progress toward or the attainment of freedom from suffering (*nirvana*) may be achieved. On the other hand, death is not to be feared as it is in the dying process that a lifetime of ITB practice pays the largest benefit. If one has managed to stabilize *rigpa* while alive, then the process of dying is relatively effortless. Awareness is continuous (with the exception of a brief moment of unconsciousness) while the transition is made from the *bardo* of the living to the *bardo* of death. Then one is thought to be able to choose either rebirth or liberation. Dying well is thought to be the ultimate attainment of one's life, the *fait accompli* of a lifetime of successful practice.

Within the Nyingma sect of Indo-Tibetan Buddhism, the most efficient method of phenomenological technology designed to realize and stabilize the nature of mind and thus effectively bridge the gap between life and death is *Dzogchen* meditation, frequently referred to as nonmeditation. In this practice, technique is set aside, there is no effort to do anything; the practitioner allows the mind to rest in its "natural state", rigpa.

The method is as follows: One gazes into empty space, not focusing on any object and remains relaxed in a state of nondistraction. The true nature of mind is found in whatever is experienced non-conceptually in naked (nonintentional) awareness, in each moment.[321] Raw experience is said to be essentially empty of inherent essence. Its arising is dependent on a variety of causes and conditions. Emptiness (Skt. *śunyata*) is said to be the essential nature of all cognitive experience regardless of conceptual content. Yet the content of conceptual experience is said to be an emanation of *rigpa*. When the conceptual mind is active, a label is given to each cognitive experience and one is attracted, averse or neutral with respect to it. Experience becomes fabricated in this way. In *Dzogchen* practice, whatever arises cognitively is not labelled. Rather, raw cognitive experience is observed nonjudgmentally. Yet, it has been said that the conceptualization of experience is not the root of the problem. Rather, the root is one's attachment to that conceptualization and consequent belief that this describes something of ontological significance.

Note that conceptual awareness is relational, involving the experiencing Self and the content of conceptual experience, language, one's preferences and predilections and personal history, etc. In contrast, pure, naked awareness, from the *Dzogchen* perspective, is thought to be non-relational since all mental content, all aspects of Self, are disengaged as they arise. And the nature of the most subtle aspect of mind is thought to exist independent of the brain.

From the neurological perspective, of course, naked awareness is relational insofar as it supervenes on the brain. One may speculate as follows. Neurologically, nirvana consists in the deconditioning of all habitually conditioned neural networks.

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[321] Ponlop, Dzogchen (2008) 104.
Preliminary preparation is necessary to utilize Dzogchen practice successfully. This consists of studying the philosophical view of the path, contemplating that view to integrate it into one's understanding and engaging in a variety of preliminary and main practices. Ibid 103. Accordingly, it is clear that *Dzogchen* practice is not conceived as a mechanical means to clear the mind. Rather, it is one component of an integrated and interdependent system.

From the DST perspective, we might describe nirvana as the elimination of all basins of attraction which represent habitual cognitive tendencies and the basins that represent the neural networks instantiating those habitual tendencies. Progress on the path to enlightenment may be described as the trajectory through phase space in which the basins representing habitual cognitive tendencies become shallower and likewise, and the basins representing the neural networks instantiating those habitual tendencies become shallower. Conversely the basins of attraction representing the PCTs become deeper. The trajectory moves toward the attractor representing insight or wisdom.

To take a specific example utilising DST analysis, let us imagine that an aspiring practitioner has a strong attachment to the personal sense of Self, a manifestation of primordial ignorance. Ignorance constitutes a strong attractor represented as a deep basin. Antidotes to self-cherishing are a bundle of PCTs (e.g. practices to equalize self and others, *tonglen*, performance of anonymous altruistic acts, meditations on no-self) which would make the basin of ignorance shallower. The basins of attraction representing the antidotes are initially shallow but become deeper as the practitioner uses them. As a result of all these practices over a long period of time the basin of ignorance is eliminated. The practitioner's trajectory through phase space eventually reaches a stable point we refer to as enlightenment.

In the ITB view, when *rigpa* is stabilized and problematic attractors are extinguished then the experience of mind in life is indistinguishable from the experience of mind in death. As far as I am aware, neuroscience has no data correlating brain states/processes with *rigpa*. James Austin has written on kensho-satori in Zen Buddhism but so far as I am aware, he has no neurological data on this state. But even if he did, there is the further question of whether the ultimate state in Zen corresponds to the ultimate state in ITB. This would be a fertile area of research since it would provide cross-cultural insight into the neural correlates, if any, of nonintentional awareness.

Those Vajrayana practitioners who have been successful in stabilizing rigpa while alive remain in that state as the dying process proceeds. According to tradition, death proceeds in a relatively fixed pattern, grosser elements being absorbed into more subtle elements: earth into water, water into air, air into consciousness and consciousness into space. As this process proceeds, sense perceptions deteriorate and disappear. There are signs that accompany the deterioration of each element and the practitioner is encouraged to become familiar with these. As deterioration precedes, mind experiences the signs of elemental deterioration and eventually the gross or conceptual mind deteriorates and disappears. Then the most subtle mind remains. This is referred to as the Ground Luminosity. A detailed description of dissolution follows.

According to ITB, the process takes place in two stages: outer dissolution and inner dissolution. The outer dissolution consists of the deterioration of the five physical senses and the subtle elements that support them. First, the senses deteriorate. Then the subtle elements that support them are re-absorbed. The dying person's energy is concentrated at a point in the subtle body known as the heart centre (Skt.chakra). The breathing slows and finally stops. This is the point at which organismic function ceases. According to medical science, at this point the person is considered dead. However, this is when inner dissolution begins according to the ITB tradition. Now mind functions free of body. Inner dissolution of gross and subtle levels of thought and emotion known as the three poisons---anger, desire/attachment and ignorance---occurs. The inner dissolution is thought to reverse the subtle process that occurred at birth. The teachings say that at birth, when father's sperm and mother's egg unite, consciousness enters the fertilized egg. During the development of the foetus, the father's (white) essence migrates to the point of the foetus' subtle energy body known as the crown chakra at the top of the head. The mother's (red) essence migrates to a point in the subtle energy body four finger widths below the navel. So during the inner dissolution, the white essence descends to the heart, the three poisons dissolve and awareness becomes pristine. The mother's red essence ascends to the heart and all desire/attachment dissolve. When the two essences meet at the heart, all the mental states constituting ignorance are dissolved, duality vanishes and the Ground Luminosity--- naked awareness--- dawns. This is also called 'the mind of the clear light of death'. According to ITB, this consciousness is the innermost subtle mind, rigpa, the real source of all consciousness. This is the point at which ITB would consider the person to have died. For one unaccustomed to experiencing this state, it would flash by in an instant and one would be unaware of it. Hence, its description as very subtle and its invisibility to scientific investigation. But an accomplished practitioner who has sufficiently refined perceptual capacities will be able to experience and abide in this state for a period of time. So, according to ITB, there is a period during which mind and mental function is free of the physical body.

One's ability to remain aware during the dissolution process depends on the practitioner's mental training. For those who have been unsuccessful in stabilizing rigpa while alive and who have unresolved negative emotional and psychological tendencies, one is unable to remain aware during dissolution. Therefore, other techniques are taught. *Phowa* is a relatively straightforward technique that almost any practitioner can master with diligent practice. One imagines or visualizes above one's head the figure of a being such as a deity or saint who one holds in high regard, imagines oneself absorbed into it and projects one's consciousness into that being. The understanding is that the visualized being is, in some sense, a representation of one's own perfected nature, not an external entity. Thus, one metaphorically "projects into" one's true nature. And for those unable to accomplish this, one may simply pray for assistance from one's preceptor. In any case, one's mental experience after death is in accordance with one's mental tendencies during one's life. This is the essence of *karma*.

From the perspective of dynamic systems, *karma* may be thought of as an attractor in phase space represented with a deep basin; its landscape is continuous from lifetime to lifetime but one's actions in this lifetime cause changes in the landscape that corresponds to future lives. If karma is conceived as momentum, then the parameters that minimize that momentum are those that make shallower the basin of karma. The Tibetan Book of the Dead is one tool which serves that purpose.

According to the *Bardo Thodol* (The Tibetan book of the Dead), the mental continuum of the deceased abides in the *bardo* of death for a maximum of 49 days. During this period, this book is read to the deceased. It describes the nature of one's experience and advises the deceased as to how to proceed toward enlightenment. Essentially, deceased is repeatedly advised that their *bardo* experience is caused by their mental projections based on unresolved habitual mental tendencies during their lifetime. The deceased is advised to realize this fact and take control of their mental continuum by recognizing that they are the creator of their experience. The task is analogous to waking in a dream (lucid dreaming) to realize that one is dreaming, then acting within the dream in accordance with one's wishes.

One preparatory practice for awakening to awareness in the *bardo* of death is dream yoga in which one trains in lucid dreaming.[322] As one gains proficiency in this practice, one eventually may be able to abide in the deepest state of pure awareness within the dream. Just as the content of the dream is one's mental projections, the content of the conceptual mind when awake is also one's mental projections.

Another practice for awakening to awareness in the *bardo* of death may also be used to facilitate awakening in dream yoga. It requires that one repeatedly conceive of one's experience of life while awake as dream-like. One repeatedly strives to recognize that all worldly appearances are dream-like in the sense that what one experiences is impermanent, insubstantial and conditioned. Essentially, the analogy (and therefore, the continuity) of cognitive experiences of life, dreaming and death is cemented.

Together with death practices, these two practices focus on the similarity of mental experience in life, dreaming and death. In each, mind plays a critical part in structuring experience based on one's emotional, psychological and habitual tendencies. And in waking life, dreaming and death, the essential task is to abide in primordial awareness.

One who is successful in realizing and stabilizing *rigpa* is optimally competent to function in the world. It is said that they see things as they are rather than projecting their conditioned experience. Because one is not trapped by conditioned or habitual behaviours and beliefs, one is able to be more compassionate in appropriate circumstances and is able to separate what is conventionally real from what is ultimately real. For such a person, death is faced as a reality to be skilfully negotiated by engaging the process of cleansing the mind from all that obscures insight. Then one abides in pure awareness as they transition from the *bardo* of life to the *bardo* of death.

7.5. Mind, Death, Technology and Dynamic Systems

ITB can be theorized as a systems-based view of life and death. One's life circumstances may be said to be caused by *karma*, past and present deeds and cognitive tendencies. But

[322] Thompson, E. (2015) ; H.H.The Dalai Lama (1997). *Sleeping, dreaming and dying.* Somerville, Mass: Wisdom Publications; Norbu, Namkhai (1992). *Dream yoga and the practice of natural light.* Ithaca, N.Y.: Snow Lion Publications; Wangyal, Tenzin (1998). *The Tibetan yogas of dream and sleep.* Ithaca, N.Y.: Snow Lion Publications.

present intentions and actions may change one's karmic trajectory. Thus, *karma* is not destiny but rather momentum. As described above, one may intervene in that momentum through the various Buddhist practices designed to disengage negative emotions and habitual behaviours, thus purifying one's mental continuum. Awareness, focus, and persistence are key. Many forms of meditation, other practices and trainings are offered as tools to hone the mind. As *karma* is purified, awareness is said to become pristine, attention becomes steadier and more focused, and perception becomes more acute.

In systems terms, if for example, the neophyte is unskilled in meditation initially, then it may not be a significant factor in their mental development at that time. The basin representing meditation is initially shallow and so exerts little influence on their state or trajectory. As one becomes more proficient in meditation, its basin becomes deeper and its influence on one's trajectory strengthens. Again, for the neophyte whose meditation practice is not strong initially, refraining from negative actions may be the most effective means to purify the mind during that time. If the attractor basin representing negative actions initially is deep, it will become shallower as virtuous actions become habitual and the basin of attraction representing meditation becomes deeper. As mindfulness becomes increasingly stabilise and awareness is undistracted, mindfulness becomes a potent tool, an attractor with a deep basin of attraction. Mind is then able to navigate the dying process with continuous awareness. Mindfulness both in meditation and in all the activities of life hones and stabilises awareness by deepening its basin of attraction. The trajectory of the practitioner's progress through phase space traces a path which approximates the attractor of enlightenment as the basins of attraction representing karma, self-cherishing, negative thoughts and actions become shallower and the basins representing egolessness and compassion become deeper.

In both medical science and ITB, technology plays a key role in the processes of death and dying. And within these processes, in both ITB and medicine, mind is central to the understanding of these processes but in very different ways. In medical science, with the development of new technologies, death can sometimes be interrupted and re-scripted. The process of technological and scientific development is analytic whereas the technology of ITB is phenomenological.

From the DST perspective, one way to think of the two technologies comparatively is that they both alter the landscape in phase space representing the process of dying. Thus considered, they are not so different.

The AWARE study demonstrates that there is much to learn about brain function in the processes of death and dying, and it presents the challenge of explaining phenomenological experiences of the "after-life". Likewise, ITB claims to have demonstrated that phenomenological technologies can play a critical role in the processes of dying and even death. Specifically, it conceives mind as a continuous and connected process bridging cognitive experiences in waking life, dreaming, dying and death. And, it is believed that mind can be trained to navigate these terrains by honing awareness and focus to an extent not explored by science, until quite recently. Of course, both ITB and medical science have developed within broader social and historical contexts which have in turn shaped the development of the respective technologies. Certainly, any methodology designed to study the mind narrows and focuses the scope of inquiry according to its underlying assumptions and the technology available for research. All methodologies must be contextualized since they have developed within specific social and historical milieus. Then, we notice that there are numerous factors, some more obviously causal, others peripheral yet nevertheless necessary to make a methodology useful, even possible. And depending upon the question being researched, some of these so-called peripheral factors may need to be considered.

When we compare research on death from the perspectives of ITB and medical science, for example, in each case, context is a significant attractor or perhaps, context is the very nature of phase space. Since the goals of ITB and medical science are entirely different---eliminating suffering by eliminating cognitive elusion versus eliminating the symptoms and cause of disease---the conceptual frameworks and methodologies are necessarily different. Yet both are appropriate for their respective purposes.

Death is an abstract term, a process with no immutable boundary. Rather, the boundary is defined relative to time and place, to the context and means available to determine it. Death (or near death) is an attractor represented with a shallow or deep basin depending upon whether there are means available to intervene, reverse the cause of death and resuscitate the individual. Dynamic systems theory is well suited as a framework for a systems study of death and dying both from the perspectives of ITB and medical science. Researching *rigpa* neurophenomenologically in wakefulness, deep sleep, lucid dreaming and even dying and death will shed light on mental function. Such research in turn would yield additional knowledge of brain function which may facilitate the development of artefactual and phenomenological cognitive technologies to bring about the states claimed to be experienced by advanced ITB practitioners and perhaps even to allow individuals to participate more consciously in the process of dying. Research in the areas of death and dying are an important part of the eco-dynamic paradigm, discussed in the next chapter.

Chapter 8

The Eco-Dynamic Paradigm

"The term 'naturalism' has no very precise meaning in contemporary philosophy. Its current usage derives from debates in America in the first half of the last century. The self-proclaimed 'naturalists' from that period included John Dewey, Ernest Nagel, Sidney Hook and Roy Wood Sellars. These philosophers aimed to ally philosophy more closely with science. They urged that reality is exhausted by nature, containing nothing 'supernatural' and that the scientific method should be used to investigate all areas of reality, including the 'human spirit'."[323]

8.0. Introduction

In chapters 2 through 5, I have argued that living organisms are autonomous, cognitive beings that enact their own world through dynamic, complex coupling with the world and their experience in that domain. Specifically, chapter 2 focuses on autopoiesis and ancillary concepts important to Varela's et al. conception life and mind. I have shown in chapter 3 that research in epigenetics and neuroplasticity demonstrates that the brain-body-world schema of enactivism is the proper conceptual framework to understand the dynamic, functional processes of genome-brain interaction. Chapter 4 builds on chapters 2 and 3, expanding on the complex interactions cutting across brain-body and world, demonstrating the interdependence of social relations, the epigenome and brain in the establishment and maintenance of mind and the possibility of analysing these relationships using the qualitative aspects of DST. Chapter 5 argues that, at an expanded scale, technology is another feature of culture that co-structures the mind. I argue that the development of several emerging and anticipated technological developments in neuroscience, genetics and medical science create the possibility of co-equalling biological self-organisation in the establishment of mind. As discussed in chapter 2, autopoiesis is understood as the self-

[323] Papineau, D. Naturalism. *The Stanford Encyclopedia of Philosophy* (Winter 2016 Edition)., Edward N. Zalta (ed.)., https://plato.stanford.edu/archives/win2016/entries/naturalism/.
Naturalists have varying commitments. The philosophers identified in the Papineau quote were both ontological and methodological naturalists. The distinction between these two positions is discussed below.

organization of living entities which arises as a result of autonomy (although not independent of environmental factors).

The possibility that technology may co-equal biological self-organisation refers to the possibility that humans may develop the means to intervene to a greater extent in biological processes with the development of advanced technology. In both chapters 4 and 5, I continue to make the case that the dynamic framework is an excellent explanatory model for analysing the subject matter of the chapters at their respective scales. Chapter 6 utilizes Indo-Tibetan Buddhism as a case study in the eco-dynamic paradigm. In particular, the recognition of mental plasticity, the recursive, dynamic interplay amongst phenomenological cognitive technologies and cultural rituals, the use of PCTs in death practices and the utility of the dynamic framework in analysing these interrelationships are important elements both in ITB and in the eco-dynamic paradigm. I further develop the paradigm in the present chapter. Chapter 7 focuses on death and dying as a means of considering the nature of the mind from an transcultural perspective. It raises the question of whether, in light of recent cross-cultural research such as the AWARE study and the ITB concept of death and dying, the naturalistic model of mind might need modification. This question is also considered in this chapter.

The foregoing chapters relied on the foundation of naturalism with respect to the mind, and I implicitly equated naturalism with the scientific method. Chapter 6, which discusses the Indo-Tibetan view of mind and cognition, could be interpreted as presenting a challenge to the naturalistic view of mind. Below I clarify my use of the terms naturalism and physicalism. Chapter 7 explicitly questions the physicalist view by presenting the phenomenon of death as a situation in which mental function is alleged, according to ITB, to be nonidentical with brain function.

This chapter presents what I call the eco-dynamic paradigm, which modifies and supplements enactivism. The first seven chapters of this dissertation laid the foundation for this paradigm. The term ‘eco-dynamic’ incorporates two interdependent aspects of DST; namely the position that mind is established and maintained by a mixture of features that span the boundaries of brain, body and world, (i.e. metaphorically, an “ecology of mind”) and that this establishment and maintenance requires a complex set of processes that are continuously unfolding in time, hence the dynamic portion of the name.

The dissertation focuses on topics not discussed by enactivists, such as death and dying and raises the question as to whether, what ITB describes as primordial mind *(rigpa*) and some mental content might be ineffable and if so, what the implications for scientific research might be. And the paradigm recommends modifications to the classic scientific method when studying the human mind. It proposes the use of first person data (e.g. neurophenomenology), as the means to capture the subjective element of consciousness and correlate it with neurophysiological data; it proposes an integrated methodology consisting of reductionism when investigating synchronic mechanisms of function and system dynamics when researching diachronic functional mechanisms; and it proposes coordination dynamics as a means of conceptualizing the conciliation of apparent opposites such as the materiality and putative immateriality of mind. The paradigm also uses trans-cultural comparisons and concepts to challenge (without denying) physicalist assumptions of the standard scientific method.

Historical and social contexts are significant factors when considering the establishment and maintenance of mind and the manner in which mind is theorized. They strongly influence the assumptions made, hypotheses researched, methodologies employed, and technologies utilized to investigate the hypotheses. The quotation from Papineau above is transparent with regard to the social and historical context from which the term 'naturalism' derives. Few philosophers (or scientists) would disagree with this statement. Despite the fact that this dissertation asserts a naturalistic stance, I find the second conjunct of the last sentence potentially (but not necessarily) problematic insofar as it runs the risk of conflating naturalism with the scientific method with respect to the mind. First, it is necessary to discuss my use of the terms physicalism and naturalism and further, to distinguish methodological and ontological varieties of each.

I equate ontological naturalism (ON) and ontological physicalism. Both positions may be referred to as 'strong' and both take the perspective that reality is exhausted by physical phenomena. I equate methodological naturalism (MN) and methodological physicalism. This position holds that the scientific method may be used to study the nature of reality. MN is 'weak' in the sense that this approach is adopted not as a foundational assumption but rather, as a working hypothesis.

The problem that arises when ON is adopted to investigate ITB theories of mind is that such theories cannot be investigated in an unbiased manner. Because physicalism is a core assumption of ON and ITB theorises that mind is not physical, the core assumptions of ON and ITB theories of mind are in conflict. In order to consider ITB theories of mind in an unbiased manner, the eco-dynamic paradigm takes the MN stance with respect to mind with one significant caveat.

A problem with the scientific method as regards the investigation of consciousness is that it recognizes the value of only "objective" data such as neural correlates of cognition and discounts subjective data such as the phenomenological component of these correlates. Specifically, the scientific method is suspicious of neurophenomenology because the phenomenological component of the method is allegedly unverifiable by third party methodology. While it is, of course, necessary to be concerned with the quality of subjective data, I argue that it is also necessary to incorporate such data when the subject of investigation is human consciousness, for the phenomenological component of human consciousness is inherently subjective and irreducible. Accordingly, Varela et al. required subjective data to be provided together with objective data. And Varela was firm in his belief that cognitive scientists who were to work with subject data would themselves need to become expert in phenomenological methodology. He said:

> "[M]y proposal represents … a call for transforming the style and values of the research community itself. Unless we accept that at this point in intellectual and scientific history some radical re-learning is necessary, we cannot hope to move forward and break the historic cycle rejection-- fascination with consciousness in philosophy of mind and cognitive science. My proposal implies that every good student of cognitive science who is also interested in issues at the level of mental experience, must inescapably attain a level of mastery in phenomenological examination in order to work seriously with first-person accounts."[324]

Varela was addressing the problem of how to resolve the hard problem of consciousness. His point here was that the methodology of cognitive science needed to be expanded to include the phenomenological investigation of subjective experience and the training of cognitive scientists working with the phenomenological method. Of course subjects too

[324] Varela, F. J. (1996). Neurophenomenology: A methodological remedy for the hard problem. *Journal of Consciousness Studies* 3(4*).* 330-349, 346.

would be required to develop expertise in the observation of their mental states since that was the whole point of phenomenal reduction.

Dennett has been critical of neurophenomenology, yet he has acknowledged the necessity of subjective data. His method requires constraints on the use of such data, under the rubric of heterophenomenology. This method takes an 'objective' position on subjective data and uses first person *reports* but does not assume these are authoritative as to the experience reported. Rather, they are authoritative only as to the subject's belief in what they are reporting. According to Dennett, the researcher should be agnostic as to the truth of the report. He considers beliefs as theoretical fictions, "abstractions that measure or describe the complex cognitive state of a subject".[325] The content of the report is to be considered together with other data, such as behaviour, neural scans and context, to determine the reliability of the subject's report. Dennett provides the example of masked priming in which a subject is presented briefly with a priming stimulus followed quickly by a mask such as a blank rectangle. When the subject is then presented with a target stimulus with which to respond, their behaviour may demonstrate that they have registered the priming stimulus even though they deny being aware of it. Dennett's point is that individuals may be wrong about their subjective experience.

Granted that in some circumstances, subjects may be unaware of the cause of their propositional attitudes and even subjective experience and therefore may provide inaccurate reports. However, this does not negate the utility of neurophenomenology in carefully controlled experiments. Notwithstanding the possibility of false reports in certain instances, no one can be more aware of subjects' experience than the subjects themselves. The concern Dennett seeks to address, the reliability of subjective data, is understandable. But rather than invalidating the authority of subjective reports altogether, the better approach is to carefully construct experiments to minimize the possibility of inaccurate reports, for instance, by using experienced meditators who are expert at observing their own mental states. This is what the eco-dynamic paradigm proposes.

If scientists are to make progress in understanding the nature of consciousness, awareness and mental states, the traditional bounds of the scientific method need to be

[325] Dennett, D. (2003). Who's on first? Heterophenomenology explained. *Journal of Consciousness Studies* 10 (9-10). 19-30.

prudently stretched. The "prudent" qualification is necessary to maintain the integrity of the scientific method. The exclusion of subjective data presents barriers to the investigation of the phenomenological component of human consciousness. Accordingly, neurophenomenology is the method which the eco-dynamic paradigm must utilize to investigate both the subjective and neural correlates of phenomenological consciousness. And since both components are crucial to a complete understanding of human consciousness, the subjective component must not be eliminated or neglected.

There are two additional adjustments to the scientific method that must be made. Since the brain-body -world schema is constitutive of cognition, as I have argued throughout this dissertation, the enactivist approach (incorporating methodological naturalism) should be adopted. The understanding of neural mechanisms alone is insufficient to capture the full scope of the multicausal, complex interrelationships constituting cognition. Somatic as well and environmental and contextual elements must also be considered. And the analysis of these interrelationships require a method that provides the tools to evaluate and explain them at multiple scales. DST fills this bill well.

Another concern with the scientific method when examining ITB theories of consciousness is, perhaps, more subtle. According to ITB, *rigpa* is claimed to be immaterial and the experience of *rigpa* is said to be ineffable. If we take these claims as true for now, do these present barriers to scientific research? Let us explore whether *rigpa* can be the subject of research if it is ineffable.

In writing on mysticism, William James, referring to ineffability, said:

> "The handiest of the marks by which I classify a state of mind as mystical is negative. The subject of it immediately says that it defies expression, that adequate report of its contents cannot be given in words. It follows from this that its quality must be directly experienced; it cannot be imparted or transferred to others."[326]

Is the inability to express the experience of *rigpa* a problem for researching its neural correlates (if any)? What would the subject be required to express in order to make such research possible? If the research is seeking to correlate the neural patterns of *rigpa* with the report of its commencement, then all the participant would be required to do is signal

[326] James, W.(1902/n.d.). *Varieties of religious experience* New York: Random House 371.

that the experience has commenced. In this instance, the ineffability of the *rigpa* experience presents no barrier to research, as a description of *mental content* (i.e. a description which would not be possible if something is truly ineffable) is not required. Is it conceivable that the ineffability of the *rigpa* experience could present a barrier to neuroscientific research of certain hypotheses? To respond to this question, consider another mark of mystical states discussed by James, namely, their noetic quality. Of this James says:

> "…mystical states seem to those who experience them to be also states of knowledge. They are states of insight into depths of truth unplumbed by the discursive intellect. They are illuminations, revelations, full of significance and importance, all inarticulate though they remain: and as a rule they carry with them a curious sense of authority for aftertime."[327]

If the researcher is seeking to investigate the *knowledge content* of the *rigpa* experience and its neural correlates by scanning the brain, the ineffability of the content would indeed stand as an impediment since any attempted report of content would fail. Likewise, the authority that is conveyed as part and parcel of the content could not be conveyed. But even so, this gap between the description of knowledge content and the neurological scan would not be a barrier to research; rather, it would highlight the need for the neurophenomenological method. This gap would be a somewhat familiar phenomenon since we are already familiar with the "explanatory gap" between the experience of phenomenological consciousness and its neural correlates. Ineffability of the phenomenology of *rigpa* then would not present a special or unique problem.

8.1. Methodology

I propose two approaches that are integral to making headway in understanding cognition. First, an interdisciplinary approach is critical. This is widely recognized and as such, is not a deviation from the course that mainstream science and cognitive science has taken. For example, as discussed in chapter 3, the understanding of neuroplasticity requires knowledge of how epigenetic mechanisms function to create the protein necessary to modify neural structure. This is so obvious that no more need be said. The second

[327] Ibid.

approach, transculturalism, is perhaps more controversial. Varela discussed the *Madhyamaka* approach in *The Embodied Mind* and while enactivism received significant recognition, in my view, the value of *Madhyamaka* was not fully appreciated. Recently however there has been a growing interest amongst western analytic philosophers of cognitive science (and cognitive scientists) in Asian/Buddhist concepts of mind (e.g. Flanaghan, Thompson, and Austin).

In seeking to understand the nature of cognition and of mind, socio-historical context can be a limiting factor. This problem has not received due attention. The use of the mind and consequently, the meaning of the term "mind" in any society, including contemporary western society, is confined within a relatively narrow boundary created socio-historically. When the limitations of that boundary are not recognized, that boundary may be taken to be the limitation of mind. The transcultural approach challenges such limitations by introducing a different perspective and thus affords the possibility of a more expansive recognition of the nature of the mind.

8.1.1. The Eco-Dynamic Paradigm is Interdisciplinary

Like enactivism**,** the eco-dynamic paradigm posits that mind is constituted by the interdependence of brain-body-world. Genetics and epigenetics, neuroplasticity, interpersonal relationship and technological innovation are discussed in chapters 2-5 of this dissertation. This paradigm presents a challenge to a fixed, specific characterization of scientific methodology since methodology varies, to some extent, by discipline. Accordingly, the paradigm is integrative and multidisciplinary as regards diachronic, functional processes. The paradigm is integrative insofar as it draws on subject matter across multiple scales of organization (from micro to macro). And the paradigm is multidisciplinary insofar as it draws on subject matter from different disciplines. Dynamic Systems Theory too applies across disciplines and scales of organization. However, as regards research on synchronic *mechanisms of function*, the paradigm fully supports the reductionistic method.

8.1.2. The Eco-Dynamic Paradigm is Transcultural

One controversial issue with respect to the nature of mind is whether nonintentional or pure, naked awareness even exists. According to traditional phenomenological understanding since Brentano, cognition is defined as directedness toward an object. And western contemporary psychological theory generally would agree. This, of course, is based on observation and experience within the contemporary ($20^{th}/21^{st}$ century) western context. But if it is true, as I claim, that cognitive states/processes are instantiated and even defined, in part, by context, then transcultural comparison is critical to the investigation of this issue. I hypothesize that in a context significantly different from the contemporary western context, aspects of mind not commonly known in the West, because not cultivated within that context, might be demonstrated. ITB is an excellent choice for comparison, for its claim is that a quality of *rigpa* is pure, nonintentional awareness. This view, like that of phenomenology, is based, in part, on phenomenological observation and experience but within a context wholly unfamiliar to the western contemporary mindset. Indo-Tibetan meditation practitioners claim to have developed highly refined introspective skills utilizing a variety of PCTs. Accordingly, the investigation of mental states in which pure, nonintentional awareness is said to be instantiated, according to ITB, may well elucidate a few issues simultaneously: the question of whether nonintentional states of awareness exist and if so, whether context plays a significant or definitive role in the cultivation of such states. Also, the investigation of nonintentional states of awareness may show how such states are related to "canonical" mental states (e.g. beliefs, desires) in the Western tradition. The research, which would throw light on these issues should, of course, be done by a multidisciplinary team including neuroscientists, molecular biologists, philosophers and advanced ITB practitioners.

8.2. States of Mind Possibly Anomalous with Respect to Strong Physicalism

This dissertation sets contemporary science alongside ITB with regard to the establishment and maintenance of mind. As valuable as any method for investigating the mind may be, it inevitably embeds assumptions which may shape research findings. Recognition of these foundational assumptions may become more transparent by transcultural comparison. For example, contemporary science takes the ontological physicalist perspective (e.g. causal closure). According to ontological physicalism, mind is extinguished once brain function terminates. This assumption may be problematic when investigating death and dying from the ITB perspective. ITB posits that the essential nature of mind *(rigpa)* is not extinguished by death. Rather, once death occurs *rigpa* continues to function free of the body.

On the one hand, if the scientific method is used to investigate such phenomena, its assumptions must remain intact. But on the other hand, if ontological naturalism is rigidly maintained, anomalous or countervailing data may be dismissed out of hand. The solution, in this case, is to adopt physicalism as a hypothesis rather than as a foundational assumption, that is, to adopt MN as discussed above. This assumption is not inconsistent with the scientific method but is more flexible and leaves open the possibility of modification if significant anomalous or countervailing data is accumulated. Then a modified or new theory of mind might need to be generated which accommodates both this new data and all the other data. The accumulation of anomalous data in the investigation of death and dying and its analysis requires the multidisciplinary and transcultural approach.

Parenthetically, my use of the word "paradigm" as part of what I have been describing as the eco-dynamic paradigm is meant to evoke Kuhn's notion that a paradigm presents core concepts, which, in the case of the eco-dynamic paradigm, vary from the dominant strong physicalist paradigm with respect to the nature of the mind. As I have previously stated, the paradigm I advocate is what I have termed methodological or weak naturalism. However, I must add that my use of Kuhn's views should not be taken to imply that I subscribe to his theory of scientific revolutions *in toto*.

As with the eco-dynamic paradigm, the accumulation of anomalous data plays a significant role in Kuhn's theory of scientific revolutions. According to Kuhn, scientific theory is paradigm driven, that is, driven experimentally and theoretically by its core concepts. Anomalies may arise in the course of research which are either resolved or not resolved within that paradigm. If unresolved, the accumulation of anomalies may stretch a paradigm to such an extent that some scientists perceive a "crisis" with respect the ability of the paradigm to account for some new data. Then some (few) practitioners begin to question the validity of the paradigm. According to Kuhn, the dominant paradigm will not be abandoned until a credible alternate paradigm is presented.[328]

I subscribe to Kuhn's view that the accumulation of anomalous data tests the resilience of the paradigm. The attempt to accumulate anomalous data (if any) within the eco-dynamic paradigm is designed to test the dominant strong physicalist "brain-bound" paradigm with respect to the nature of the mind. Can the scientific paradigm accommodate the data provided by ITB practitioners or will the accumulation of anomalous data present a challenge?

8.2.1. Proposed Neurophenomenological Research

The purpose of this discussion is to highlight the value of the eco-dynamic paradigm as the guiding set of research principles in the proposed research programme described below. In this hypothetical programme, three ITB meditation practices would be studied. In each of the three, allegedly, a state of nonintentional awareness may be achieved by advanced ITB meditators. We would need to query whether these three states would be neurophenomenologically the same or similar. The three practices are Dzogchen meditation, dream and sleep yoga and death meditation. According to ITB, Dzogchen meditation and sleep and dream yoga are preparation for the death meditation. If this is so, there is some basis for hypothesizing that all the practices elicit the same or similar cognitive states.

Subjects who are to participate in this research must be highly advanced ITB practitioners who have developed the meditative skills necessary to achieve the cognitive states being studied, voluntarily and reliably. In each of these practices, advanced cognitive states are to be accessed in which nonintentional, pure awareness allegedly will be achieved and maintained by each participant. Since subjects practicing the death meditation would not be able to provide phenomenological reports, we would need to query whether the neuroscientific data from Dzogchen meditation and sleep yoga is substantially similar or the same as the neuroscientific data obtained during the death meditation.s

[328] Kuhn, T. (1962). *The structure of scientific revolutions.* Chicago: University of Chicago Press.

The participants would initially be interviewed and would provide a detailed case history which would include information related to the practices, rituals, and study in which they have engaged, the environment in which they have been embedded, the length of time of time in each practice, and their degree of accomplishment (as applicable). In the ITB tradition, meditative practices are supported and explained by a variety of teachings and rituals. Also, enactivism posits that mental function is constituted by the brain-body-world schema. Thus the need for a comprehensive case history. I hypothesize that there may be a correlation between the ability of the subjects to achieve and sustain target meditative states and amount of time spent training in the various ITB practices.

In the research, participants would be asked to engage in specific practices and achieve specific cognitive states. They would be asked to report when they have achieved the cognitive state requested and their brains would then be scanned during this period. Of the practices with which this research is concerned, the first and simplest practice studied would be Dzogchen meditation. A more difficult practice is sleep and dream yoga and would be researched next. In this practice, lucid dreaming would be accomplished, after which, while still asleep, deeper cognitive states would voluntarily be entered until, allegedly, pure, nonintentional awareness would be achieved and maintained. The most challenging practice is death meditation. The meditation would begin prior to the time of death (according to the whole brain-cardiopulmonary standard) and would continue after physical death has occurred (by the same standard). During this time the brain function of the subject would be monitored. The ITB claim is that when the practitioner maintains pure, nonintentional awareness there would be no discernible neural correlates. If the meditative states achieved in *Dzogchen* and sleep yoga practices are neurophenomenologically similar, if not identical, with objective data from the death meditation (if there any neural correlates in the three practices at all), then arguably this would constitute anomalous data for the dominant paradigm, but would be best explained by the eco-dynamic paradigm.

If there are neural correlates in the cases of Dzogchen meditation and sleep yoga but no neural correlates in the death meditation, the evidence would suggest that the neural status is different in the death meditation. Why is this? Is the person dead or is there another explanation? According to the tradition, in the death meditation the region of the heart remains warm for an extended period, skin remains supple and there is no observable physical deterioration. If these conditions obtain, then the data indicates that the neural state in the death meditation is different from the other two states. On the other hand, if there are no observable neural correlates in any of the three meditation practices one may speculate that either: i) the three cognitive states are similar; or ii) there is insufficient data to infer anything.

8.2.2. Dzogchen Meditation

The practice of *Dzogchen* meditation is sometimes described in ITB as “nonmeditation”. This refers to the release of any effortful practice—"just letting go”---and relaxing the mind in its “natural state”. The natural state of mind is conceived as non-intentional, open to raw perception, without judgment, concept or elaboration of any sort. The discursive mind, occupied with concepts and language, is conceived as fabricated. The term “fabrication” refers to the natural tendency of the mind to utilize the content of one’s five senses, experience, history and the like to construct the world of enculturated experience. The problem with fabrication is that it loads mind with content that is removed from actual experience, and embeds judgments, emotions and so on, which deviate from raw experience. The discursive mind, with its content and linguistic baggage, creates persistent neural patterns and structures one’s perceptions and experience of reality according to one’s history. The gloss which discursive mind places on perception is subtle, so that one tends to not realize that one is removed from the world of ‘pure’, raw experience.[329] Thus, in Dzogchen meditation, there is a need to bypass the discursive mind---bypass thought, language, concept, memory and past experience---and merely remain in the present moment of raw experience.

Because of the subtlety of the enculturated gloss on the mind, it is necessary to get assistance bypassing the discursive mind. Thus, *Dzogchen* practice requires that the

[329] Andy Clark’s discussion of the predictive mind bears a similarity to the ITB discussion above. Both conceive that mind constructs a gloss on perception that affects one’s ability to see the world as it is in the moment. Clark does not explicitly discuss this gloss and its effect on perception in the present, but it is my contention that it is implicit in his view of the brain as a “prediction machine”. One point of difference between ITB and Clark views is that Clark conceives that the gloss plays forward as prediction whereas ITB conceives that the gloss arises from past conditioning. Also, Clark does not consider whether this fabrication can be circumvented or overcome. Unlike ITB, Clark conceives the predictive mechanism as an adaptive feature of the mind. See Clark, A. (2016). *Surfing uncertainty.* Oxford: Oxford University Press.

introduction to "the nature of mind" be given by a qualified master or preceptor. Here is how Sogyal Rinpoche described his first experience of the introduction to the nature of mind:

> "Before I knew what was happening, my master did something quite unusual. He suddenly hugged me and lifted me off my feet. Then he gave me a huge kiss on the side of my face. For a long moment my mind fell away completely and I was enveloped by a tremendous tenderness, warmth, confidence and power."[330]

Here is how he described his second introduction:

> "[My master] said, 'now I am going to introduce you to the essential nature of mind'. Picking up his bell and small hand drum, he chanted the invocation of all the masters of the lineage… Suddenly he sprung on me a question with no answer: 'What is mind?' and gazed intently deep into my eyes. I was taken totally by surprise. My mind shattered. No words, no names, no thought remained—no mind, in fact, at all."
>
> "…Past thoughts had died away, the future had not yet arisen; the stream of my thoughts was cut right through. In that pure shock a gap had opened, and in that gap was laid bare a sheer, immediate awareness of the present, one that was free of any clinging. It was simple, naked and fundamental. And yet that naked simplicity was also radiant with the warmth of an immense compassion."[331]

A couple of observations are apparent from the above descriptions. First, the experience of the nature of mind is not ineffable according to the criteria set by James. The experience is endowed with qualities that Sogyal Rinpoche described. Second, the circumstances in which the introduction to the nature of mind can be made may vary. In the first instance, the introduction was informal and apparently spontaneous. In the second instance, the introduction occurred within the context of a formal ritual. So it seems apparent that a specific context is not required for the introduction or perhaps there may be several contexts that are appropriate. What each instance has in common is that the introduction was sudden and unexpected; the behaviour of the master was out of the ordinary and fully, or at least partially, in some sense, beyond words. The behaviour was designed to surprise Sogyal and stop the usual cognitive elaboration in which the discursive mind engages.

[330] Sogyal Rinpoche (1993). *The Tibetan book of living and dying.* San Francisco: Harper, San Francisco 43
[331] Ibid.

Cracking the fabricated or enculturated cognitive shell apparently opens one to unelaborated cognition. The settling of discursive mind to allow experience of the nature of mind is described by a classic ITB metaphor. The discursive mind is analogized to muddy water which is stirred by one's continual discursive cognition. Once the stirring ceases, the mud settles and the water becomes clear. The clear water is analogous to *rigpa*.

Once the introduction to the nature of mind has been made, regular Dzogchen meditation practice begins in which one can access the unfabricated mental state for oneself. In this practice, one simply rests the mind in pure awareness, the nature of mind, rigpa. The instruction, put in simple terms, is to sit upright and keep eyes open with soft, unfocused gaze. Cognition which arises spontaneously is allowed to settle with being stirred (so to speak). Eventually cognition may (or may not) cease. But what matters is that the mind rests effortlessly. The ability to access and stabilize rigpa as one's "default mental state" develops as one continues the practice.

One of the benefits of this practice is that one begins to recognize the extent to which the discursive mind fabricates its unique cognitive landscape due to primordial ignorance and enculturated experience. Gradually one then begins to free oneself of this unconscious conditioning.

8.2.3. Sleep and Dream Yoga

Both sleep and dream yoga are philosophically salient. Each elucidate different aspects of the nature of the mind and both are states of mind that may be cultivated and trained to come more under voluntary control according to ITB.

Dream yoga focuses on the cultivation and utilization of lucid dreaming, that is, the ability to become aware, within the dream, that one is dreaming. Primarily, the rationale for developing and using this practice (together with sleep yoga) is as a means of deepening awareness. These practices facilitate greater awareness both in the dream and waking states. And, according to ITB, it is possible to cultivate the continuity of awareness from the waking state to the sleeping state. Dream yoga is also utilized to demonstrate the similarity between the waking and dreaming states. In both the waking and dreaming states, conditioned cognition[332] colours one's experience. And in both, the release of conditioning, resulting in increased clarity, may be achieved through disciplined practice. From the ITB perspective, lucid dreaming is a by-product of the development of awareness and presence.[333] Thus, the practices of *śamatha* and *Dzogchen* meditations stand one in good stead in the practices of sleep and dream yoga. Eventually, one may, by voluntary means within the lucid dream, move beyond mental content to the state of pure, nonintentional awareness. This is the state cultivated in sleep yoga.

One method of developing the ability to lucidly dream is to repeatedly remind oneself that the waking state is like the dreaming state.[334] Both when awake and in a dream, the discursive mind creates one's conditioned experience. And in both the waking and dreaming states, it is believed that one may train the mind to "wake up" to unconditioned, pure awareness. The barrier between waking awareness and sleeping awareness is thought to be porous.

Sleep yoga is a more difficult practice than dream yoga and takes a considerable amount of meditative stabilization. It is understood as deep, lucid, nonintentional sleep, in other words, pure awareness. It is also known as clear light sleep. It may be accessed in two ways. First, just as one begins to fall sleep, pure awareness may be experienced. According to Dzogchen Ponlop:

> "Primarily, we should try to directly experience the true nature of mind at the very moment of the dissolution of the waking state. At that time, we generate bodhicitta [the wish to attain enlightenment in order to benefit all sentient beings] and, without being interrupted by other thoughts, we look with mindfulness and awareness directly at the mind itself with the intention of observing its aspect of clarity. At the very moment of dropping off to sleep, it is taught that pure awareness shines clearly, full of vivid and bright qualities."[335]

[332] In this context, conditioned cognition refers to two types of ignorance, according to ITB. These are primordial ignorance, the condition of most human beings, and conditioned or enculturated ignorance.
[333] Norbu, Namkhai (1992). *Dream yoga and the practice of natural light* Ithaca, NY: Snow Lion Publications. 33
[334] Ibid.42.
[335] Dzogchen Ponlop quoted in Thompson, E. (2015). *Waking, dreaming, being.* New York: Columbia University Press. 266-267.

The moment of pure awareness is very brief and if one's attention is not finely attuned, then one is unlikely to be able to abide in it. Repeated effort is typically required. Therefore it is important for research purposes that expert meditators are subjects.

The second opportunity to abide in pure awareness occurs in the lucid dream state. Within the dream, one dissolves the content of the dream and rests in the awareness of being aware.[336]

Sleep is analogized to death in ITB. As with death, in sleep, one "dies" to the waking state and at least for a moment, one becomes unconscious. But with training and practice, ITB asserts that one can experience continual pure, nonintentional awareness both while asleep and in the process of dying and into death.

8.2.4. Death Meditation

Because enactivism has almost nothing to say about death and dying, it provides few resources as a guiding paradigm in the investigation of the proposed research. Recall the 5 pithy principles of enactivism previously stated in section 2.0. To summarize briefly: Living beings are autonomous agents that bring forth their cognitive domains; the nervous system is an autonomous dynamic system; cognition is the exercise of skilful know how in embodied, situated action; a cognitive being's relational domain is brought forth by its coupling with the environment; and experience is central to the understanding of mind and needs to be investigated phenomenologically.[337] Note that these principles are concerned with living, cognitive being's self-organization and enaction within the world.

One can only speculate why enactivism is silent about death and dying. Perhaps in part, as a response to the computational metaphor of mind, enactivism sought to demonstrate that the brain-body-world schema was constitutive of mind. And enactivism posits that cognition manifests in all *living* entities-- the mind-life continuity thesis. Additionally, Thompson says that the enactive approach offers important resources to make progress on the explanatory gap. And it explicates selfhood and subjectivity from the ground up. With all this I would agree, but as enactivism has matured, it has yet to consider the flipside of

[336] Ibid.267.

[337] Thompson, E. (2007) 13

autopoiesis, that is, the dissolution of self-organization. Is this because, from the enactivist viewpoint, there is nothing to say or just because it has not been a part of the enactivist agenda to date? Thompson (2015) discusses death in a whole chapter, but he does not attempt to incorporate death and dying into the enactivist approach. In my view, this lapse needs correction.

Both the enactivist and eco-dynamic paradigms recognize that mind can be trained to be more acute. Brain and mind are plastic. But only the eco-dynamic paradigm asks whether PCTs can be utilized to affect the experience of dying and perhaps even death itself. However this characterization perhaps lacks subtlety, for western medical science also uses technology, albeit artefactual, to affect the dynamics and perhaps the experience of death. The transcultural comparison is particularly poignant in this regard, because there is a world of phenomenological difference between being the passive recipient of ACT and being actively engaged in PCT. And there is clinical evidence in medicine generally that a patient's active involvement in diagnosis and treatment gives rise to more successful outcomes. In seeking to understand the potential of voluntary mental function to affect both the body and mind in the process of dying, the transcultural perspective is critical.

In the ITB practice of the death meditation, the practitioner, while alive, enters into the cognitive state of pure, nonintentional awareness referred to in this context as the clear light of death, (which I have previously hypothesized to be similar to or identical with *rigpa*) and remains in that state through the first dissolution (of body) and second dissolution (of mind). Traditionally the death meditation is said to continue for three days, although in practice the time period is said to vary. During this time, allegedly, the body does not decay.

The transcultural approach of the eco-dynamic paradigm highlights data seemingly anomalous to strong physicalism which, most likely, would not be revealed without such an approach. It must be said, however, that recent developments in western perithanatic (near death) research has brought the eastern and western views into proximity. For example, the AWARE study revealed that 10% of those who had a near death experience claimed to have cognitive experience seemingly without brain function. And again, medical science recognizes that death is a process in which organs cease to function at varying rates. Yet this data, evaluated within the framework of ontological naturalism, does not allow for theories alternative of physicalism.

The eco-dynamic paradigm comes most clearly into play with accumulated data which would, *prima facie*, appear to challenge, or stronger yet, contravene the strong physicalist assumption of mind. This is most apparent in research on the death meditation where, it is claimed, the region of the heart remains warm for an extended period of time and physical decomposition does not occur even though one is deceased by Western standards. In the eco-dynamic paradigm, since naturalism is a hypothesis rather than a foundational assumption in this paradigm, room is left for alternative or supplemented hypotheses. Transcultural research in death and dying is potentially one of the richest areas in which anomalous data may be amassed, specifically related to ITB PCTs.

Extraordinary claims have been made and anecdotal evidence provided about ITB practices and practitioners' experience of death and dying. Most of these involve mental practices and benefits attained as a result. Data accumulated from such research might provide an enlarged understanding of the nature of the mind and mental function.

8.3. Dissolution of Self-Organization as a Criterion of Death

According to enactivism, autopoiesis is the minimal criterion of life, although as seen previously (section 2.1.2), perhaps not definitively so. This view is also adopted by the eco-dynamic paradigm. Additionally, the dissolution of self-organization, as determined by metabolic deterioration or cell death (apoptosis), is the criterion of death in the eco-dynamic paradigm. This criterion is similar to the criterion of ITB, according to which death is said to occur only after self-organization of the physical body deteriorates, that is, after the death meditation has terminated. However, ITB does not focus on the state of the body but rather on the mind (as evidenced by the body) during the process of the second dissolution and beyond. Here physical deterioration is seen as the effect, not the cause of the second dissolution. The understanding is that mind structures the body. So, for an advanced practitioner, while remaining in the death meditation, allegedly, there is no physical deterioration.

The eco dynamic rationale for the dissolution of self-organization criterion follows logically from autopoiesis as the criterion for life. If autopoiesis is the criterion of life, then its dissolution is the criterion of death. How does this criterion compare with the whole brain-cardiopulmonary standard? Let us consider a case. An individual drowns in cold water and is recovered but shows no brain or cardiopulmonary function. From previous instances of cold water drowning, it is known that cellular apoptosis is slowed or stopped by the drop in bodily temperature. Thus, it is known that such individuals may be revived within a certain, but extended, period of time if the necessary equipment is available. However, only with accumulated knowledge of prior cases of cold water drowning is it known that such cases should be treated as an exception to the 'whole brain cardiopulmonary' standard. Prior to the accumulation of this knowledge, individuals who might have been saved where not saved until this exception was discovered. The same is true with certain cases of drug toxicity. Exceptions are made to the whole brain-cardiopulmonary standard due to prior accumulated experience in many such cases. Again, this means that before experience of this exception was accumulated, individuals who might have been revived were treated as dead, that is, not an exception to the standard.

Consider one final case. An advanced ITB practitioner has "died" according to the whole brain-cardiopulmonary standard; no brain or cardiopulmonary function is present but the heart region remains warm and minimal or no physical deterioration occurs. If the western standard was applied , the practitioner might be buried prematurely (from the ITB and eco-dynamic standard). This is important because in some cases, such practitioners have, reportedly, revived for a time.

Compare these cases with the same cases in which dissolution of self-organization is the standard. By monitoring cellular apoptosis, it may become clear that normal physical deterioration is not occurring. This does not require the same body of accumulated experience as in the former cases in which the whole brain standard of death governs. So even the first such patient is not judged and prematurely declared dead.

As a practical matter, the dissolution of self-organization standard could be an additional criterion supplementing the more traditional approach. In this case, if the person is considered dead by the traditional western standard but not by the self-organization standard, they would not be considered dead. In such a case, further assessment might be required to determine the cause of lack of deterioration or perhaps just a period of observation. Merely supplementing but not superseding the traditional criteria, the objection to this additional standard might be less robust.

8.4. Dynamic Systems Theory of Near Death

Throughout this dissertation, I have argued that cognitive function is a component of mind. The ITB notion of mind challenges the equivalence of mental function with brain function. While I have stated that physicalism is merely a hypothesis, nevertheless, the thesis that environment and interpersonal relationship, in part, establish and maintain mind indicates my predisposition to the functionalist perspective. Perhaps it may seem paradoxical or even contradictory then, on the one hand to take a functionalist and nonreductive physicalist stance on mind and, on the other hand, to challenge that position with the ITB view of mind as not physical; and further, to suggest the pursuit of a research agenda related to death and dying that brings these two positions into competition. This comparison might appear to bring the MN and ON stances into a state of tension. But as previously stated, I believe that taking the physicalist view not as foundational but merely as a hypothesis allows for a healthy dialogue between MN and ON.

The close correlation between brain function and mental function does not, *ipso facto,* prove physicalism, although it is very strong evidence. The eco-dynamic paradigm considers differing and perhaps opposing conceptions of mind in order to critique and perhaps modify the strong physicalist position if the accumulation of anomalous data demonstrates the necessity.

As I have demonstrated in chapters 2-5, a similar perspective is taken by dynamic systems theory. This framework is capable of accurately describing the dynamics of mind at multiple scales.

Consider the cases I discussed earlier in this chapter from the perspective of dynamic systems theory. Let us take the case of drowning in cold water. The temperature of the water matters. If it is too warm, cellular apoptosis may damage the body beyond the possibility of resuscitation and if it is too cold there may also be cellular damage. So water temperature is a parameter. Also, the length of time the victim is in the water, the length of time it takes to recover the body from the water and length of time it takes to provide life support are also parameters. Cellular apoptosis happens at different rates for different organs. So timing and rates of change in cellular apoptosis are also relevant factors. But since changes in time-rate are in the nature of dynamic systems, these features are not separately specified as parameters. Rather, they are features of parameters themselves (e.g. cellular apoptosis). Other parameters include the availability of skilled and experienced medical personnel to administer treatment and the availability of medical equipment necessary to monitor and artificially maintain cardiopulmonary and all other necessary bodily functions. And of course, the condition of the victim is a parameter. For example, if they had a heart attack which could not be corrected, then condition of the heart would be a point attractor and that alone would determine that the victim would not be resuscitated. However, if the cause of the heart attack could be repaired, the victim was otherwise in good health, all necessary facilities and equipment were available and experienced personnel were present to intervene in a timely manner, then the trajectory through state space of recovery would depend on adequate depths of basins for all attractors. Adequate conditions for recovery in dynamic systems terms is the proper balance of depths of basins of all attractors. But if the general physical condition of the victim is not good and other control parameters of suboptimal, then the victim's recovery would be represented by a trajectory in phase space which skews away from the "ideal" trajectory. In this case, temporal, biological, physiological, personnel, technological and environmental factors, operating at multiple scales, both independently and interdependently, constitute parameters which will determine whether or not the victim recovers.

I will provide a more detailed hypothetical example with some variations. Let us suppose the victim has a heart attack and drowns in cold water. The cause of the heart attack is an embolism which could be surgically removed. The body temperature is cooled by the water and cellular stability is maintained for a time. Ambient air temperature outside is 25 degrees Centigrade. The body is recovered but the only personnel immediately available to administer help is an emergency medical technician (EMT) with no equipment available. She administers chest compressions but is unsuccessful in resuscitating the victim. The victim is transported to a hospital but transport is delayed. One hour lapses from the time the body is recovered to the time the victim is in hospital. In this interval, core body temperature warms. The hospital does have the cardiopulmonary equipment necessary to artificially maintain circulatory and pulmonary function but does not have the equipment needed to maintain body temperature at a low and stable temperature.

The condition of the heart is an attractor with a deep basin. Body temperature changes as a function of time under varying conditions and this basin of attraction is very deep. Other attractors are: i) Availability of necessary equipment (deep basin as regards equipment some of which is in opposition ---positive for cardiopulmonary and negative for temp regulation); ii) Availability of EMT (shallow basin). Transport time and other timing factors are built in to the body temperature of the victim. (moderately deep basin). Some attractors favour recovery and others do not. The trajectory through phase space depends on the balance of these.

In the next variation, the EMT has a portable defibrillator and administers a shock directly into the heart. The victim shows signs of life (an erratic heartbeat and minimal respiration). The victim is transported to the hospital quickly and the core body temperature remains cool. In this case, the technology is a parameter and the trajectory in phase space is highly unstable. In dynamic systems terms, the goal of medical personnel is to stabilize the trajectory in phase space by means of one or more additional parameters, ideally with steep basins of attraction. The ambulance quickly arrives at a state of the art high tech hospital. The patient's condition is stable and she is quickly placed on life support. A medical team expert in resuscitation medicine is present and places the patient on machinery that administers chest compressions. Body temperature is maintained at 96 degrees Fahrenheit so minimal cellular apoptosis occurs. The patient quickly is put through a battery of tests to determine whether there any other causes of death. Water is drained from the lungs and an EEG monitors brain function. The patient is otherwise in good health and there are no other contributing causes of death. The patient's body temperature is gradually raised to 98.6 F. The patient remains in a coma.

From the DST perspective, the trajectory through phase space represents the condition of the victim. Each parameter is favourable to minimise bodily damage. In this case, the parameters (as represented by deep basins of attraction) give the patient the best chance of recovery. That is determined by the ability of the body (including the brain, of course) to recover.

Consider the next variation of several Buddhist meditators who are dying and who have varying degrees of meditative accomplishment in consistently sustaining *rigpa*. The more advanced meditators have also practiced dream and sleep yoga. Of these, the most advanced have been able to move wilfully and consistently from the lucid dream state to clear light state, that is, the state of pure, nonintentional awareness, *rigpa*. For all meditators, their state of mind throughout their dying processes and their relative ability to remain (or not) in the death meditation are parameters. The years of meditative practice and their degree of accomplishment in meditative practice are predominant control factors. The basins of attraction of these two parameters are both very deep and stable in the case of the most advanced meditators and less so in the case of less practiced and accomplished meditators. Let us assume that length of meditative practice predicts degree of accomplishment and that the depths of the basins of attraction representing degree of accomplishment vary accordingly; the deeper the basin, the greater the degree of accomplishment. Environment impact also is a parameter as a calm environment facilitates the death meditation practice and a disruptive environment disturbs the practice. However, the greater the degree of meditative accomplishment, the less effect environment has on the ability to sustain the death meditation practice. So the depth of the attractor basin for this variable is inversely related to accomplishment; that is, the greater the degree of accomplishment, the shallower the basin representing environmental impact.

We can see how the trajectory through phase space varies in shape depending upon the degree of accomplishment of the practitioner. If we were to arrange the phase portraits of the meditators by degree of accomplishment (lesser accomplished to greater) as they practiced the death meditation, we would observe how the changing shapes of the attractors represented movement toward successful outcome in the death meditation.

Chapter 9

Enacting the Dying Mind

9.0. Introduction

In this final chapter, I defend my claim that the Eco-Dynamic Paradigm (EDP) fills a gap in enactivism by placing death and dying within the framework of self-organisation (autopoiesis), or more properly the dissolution of self-organisation (see section 8.3). Specifically, I will demonstrate that, while Thompson discusses death and dying in chapter 9 of his *Waking, Dreaming, Being*, he discusses the topic within naturalistic, cross-cultural and phenomenological frameworks but he does not *systematically* frame death and the dying process within the enactivist approach. I do not believe that this is an oversight; rather it is my belief that in this chapter, Thompson did not intend to incorporate dying and death within enactivism. I will demonstrate this below by contrasting the manner in which he dealt with dying with the manner in which he dealt with the self in chapter 10 of the same book. On the other hand, throughout this dissertation, I have demonstrated the deep continuity of self-organisation of living (and dying) organisms at multiple scales and their interdependence with environmental and cultural contexts for example, technology (chapter 5), cultural context (chapter 6) and the impact of technology on death and dying (chapter 7) and so, my overall position is novel and original because I do frame death and dying both within the enactivist approach.

In this chapter I also elaborate my commitment to methodological or epistemological naturalism. Having previously drawn a distinction in chapter 8 between ontological or metaphysical naturalism and epistemological or methodological naturalism, I make a further distinction which I refer to here as “assumptive” versus “presumptive” naturalism. When a researcher assumes that investigations are only worth pursuing which fit into an established scientific or philosophical paradigm, or when a researcher will only consider assumptions that fit an established paradigm of naturalism, I refer to this as assumptive naturalism. On the other hand, when a researcher presumes that investigations should be pursued the results of which might challenge an established naturalistic paradigm, I refer to this as presumptive naturalism. For my purpose I group metaphysical naturalism, ontological naturalism and assumptive naturalism together; and I group epistemic naturalism, methodological naturalism and presumptive naturalism together. Simply put, the former set takes a position on the metaphysical basis of naturalism and implements it in theory and practice. This position may result in an unwillingness to engage in certain types of research or if engaging in such research interprets the results only with respect ontological naturalism. The latter set avoids a metaphysical commitment, generally is open to any research (including but not limited to comparative research) which may shed light on the nature and function of mind and is open to considering apparently anomalous data as possibly requiring a modification of the paradigm. It is my view that presumptive naturalism should be adopted when researching death and dying from a comparative perspective. To illustrate how presumptive and assumptive naturalism might operate in a particular instance consider, for example, Traditional Chinese Medicine (TCM) which theorizes the existence of nonphysical meridians along which chi (nonphysical energy) flows. According to TCM, acupuncture is said to free blocked chi along the meridians leading to relief from symptoms and better health.

The paradigm according to which TCM operates would appear to be in conflict with the paradigm upon which western medical science is based. The assumptive naturalist might be inclined to discount data about the efficacy of acupuncture and avoid TCM research because the paradigm assumes the existence of nonphysical energy. Or she might interpret apparently anomalous data as unexplained but undoubtedly explainable (eventually) by the "normal science" activity (in the Kuhnian sense of "puzzle solving") of the Physicalist paradigm. On the other hand, the presumptive naturalist might be inclined to investigate the efficacy of acupuncture. Applying methodological naturalism, she would utilise scientific methods, theories, and instrumentation and would be open to the possibility that anomalous data (if any) might require a modification to, or shift from, the physicalist paradigm. She would be open to the possibility that the paradigm of western medical science might need to supplemented, modified or extended to account for these anomalies depending upon the results of these studies. More on this later.

I will first discuss the claim that the discussion of death and dying in chapter 7 of this dissertation constitutes an original contribution to the literature of enactivism. Thereafter, I discuss my commitment to presumptive naturalism elaborating on the distinction mentioned above.

9.1. Enacting Death and Dying

Initially, it is vital to make a distinction between, on the one hand, a discussion of death and dying in which enactivism is merely referenced and on the other hand, a discussion of death and dying which has been *systematically* incorporated into the enactivist schema. Thompson has done the former in chapter nine of his book *Waking, Dreaming, Being* in the two instances I cite below in which enactivism is referenced. I have done the latter in this dissertation.

The question I raise at the beginning of chapter 1 is “what is life?”. I explore the self-specifying or autopoietic system as a response to this question. Because I consider life and death as complementary processes, the obvious question that follows is “what is death?”. I have answered that death is constituted by the dissolution of self-organisation, the complementary process of autopoiesis both of which can be analysed using the resources of dynamical systems theory (see 8.3). Since dissolution is not independent of available artefactual and phenomenological technologies, there is mutual causality of endogenous and exogenous processes. And because these technologies evolve and develop over time, I have argued that death and dying are dynamic processes at multiple scales.

In Thompson’s chapter on death, the phenomenology of dying is given much attention. Elsewhere[338] he has also written about the phenomenology of dying. The chapter relates Thompson’s experience of the Buddhist death meditation during a retreat. He contrasts the western approach, which largely avoids one’s exposure to death and dying, to the traditions of eastern cultures in which one is not shielded from death. In fact, several Indo-Tibetan Buddhist (ITB) meditative practices are regarded as preparations for the process of dying. Specifically, Thompson discusses the Tibetan culture of dying and death in detail. And he discusses the near death and to out of body experiences. It is my view that in this chapter Thompson is exploring various interdisciplinary and cross cultural views of death in order to

[338] Thompson, E. Death: the ultimate transformative experience retrieved 27 March 2021 https://evanthompsondotme.files.wordpress.com/2017/11/thompson-revised-death-the-ultimate-transformative-experience.pdf

come to terms with his own view. He concludes that the Tibetan death meditation is a form of what he calls "ritualized phenomenology". What he does not attempt to do is bring death and dying *systematically* within the enactivist approach.

There are two points in chapter 9 where Thompson parenthetically references enactivism. But it is my contention that in neither of these references does Thompson bring death or dying *systematically* within the enactivist approach.

The first reference is at the end of chapter 9.

> "The advantage of this neurophenomenological approach is that it can help us to see near-death experiences from multiple physiological, psychological, cultural , spiritual and phenomenological perspectives without reducing the experiences to any of these perspectives." [339]

The context in which this statement arises is that Thompson is talking about the "ungraspability" of one's own death and how it requires one to cultivate a tolerance of uncertainty and not knowing. Because own's own death is an existential issue, a purely physical understanding of death is inadequate. According to Thompson, a detailed phenomenological investigation of near-death experience is required. He says that "with this richer qualitative information we can relate near-death experience more precisely to the person's individual brain and body, as well as culture and life circumstances." [340]

What he doesn't say, but the reader might infer, is that a neurophenomenological account of the near death experience takes a step toward understanding the phenomenology of death. But I do not think this is not so because accounts of the experience of others who have suffered near death does not come closer to helping one "grasp" the phenomenology of one's own death. Rather, the experience of one's own death is intensely personal. And although this quotation points in the direction of enactivism it does not sufficiently bring death or near death within the enactivist approach. Thompson does relate brain, body, culture and life circumstance to the near death experience but more would be needed, for example, the demonstration and explication of the dynamic mutual causality of brain, body, and culture in the processes of near-death and dying. The reference to the neurophenomenological approach in near-death experience, without further discussion, does not *per se* bring death and dying within the framework of

[339] Thompson (2015) 318
[340] ibid

enactivism. This dissertation takes that extra step by showing the dynamic interdependence of biology, psychology, culture, technology and death and dying.

The second instance in which Thompson might appear to bring death within the enactive framework is in his discussion of the Tibetan Buddhist account of death. He says

> "It would be a mistake however to think that the Tibetan Buddhist account of death must be either literally true or false. Instead, we can see it as a script for enacting certain states of consciousness as one dies. In this way, it is more performative and prescriptive than descriptive. Looked at from the outside, the Tibetan Buddhist account of death strikes me as a "ritualized phenomenology". The dissolution meditation doesn't so much present a phenomenological description of death as rehearse and enact a phenomenology of death as a ritual performance"[341]

Again, this quote references the enactive perspective this time a bit more closely but it is not framed more widely within the framework of enactivism. His use of the term "enact" gestures toward the interdependence of cultural and phenomenological components. But he puts this forward as an hypothesis or suggestion that needs to be explored more fully. This is what I have done.

Furthermore the Tibetan Buddhist account of meditation, culminating in death, is more nuanced than this reference suggests. Ritualized phenomenology may be an accurate description of one aspect of the death meditation and meditation in general but there is much more to be considered. According to ITB, atypical or anomalous physical symptoms (from a physicalist perspective) result from thukdam, the Tibetan meditative practice used while one is dying. (see 7.1). Thus research into the Tibetan death meditation is well advised and suggested in chapter 8.

The EDP would propose the ITB account of death and dying as a fertile ground for researching the impact of phenomenal cognitive technology (PCT) on death and dying. Claims that the heart region remains warm for an extended period while the person is clinically dead may provide sufficient motivation to pursue further investigation. The researcher need not believe or disbelieve the ITB account. She may (or may not) have a metaphysical presupposition but because she may consider the account sufficiently interesting and potentially illuminating, she might pursue the research using the scientific method I have suggested. This is the approach of presumptive naturalism.

[341] Ibid 291

Beyond these two references in chapter 9, Thompson discusses death and dying outside the enactivist framework; his experience of a Buddhist dying meditation; the Tibetan Buddhist view of dying and death; an examination of cases in which Tibetan Buddhist masters engaged in the death meditation as they were dying, the examination of these from the scientific point of view; and whether near-death experiences demonstrate the independence of mind and body; and the "ungraspability" of one's own death. None of these discussions specifically relate death and dying to enactivism although they do utilise the phenomenological or scientific approach both of which are employed by enactivism

Contrast Thompson's approach to death and dying to his discussion of the self in chapter 10. In this chapter it is clear that Thompson intends to consider the self from the perspective of enactivism. He does this by referencing enactivist concepts and analogising these in his discussion of the self. This is in contrast to what Thompson does in his chapter 9 in which he parenthetically references enactivism without more thoroughly integrating death and dying. In chapter 10 Thompson takes an approach which I have taken in the dissertation; he considers the self in relation to 3 scales: biological, psychological and social. In a section entitled "The enactive approach to the self" he proposes that "self is a process of I-ing---an ongoing process that enacts an I and in which the I is no different that the process itself."[342] The term "I-making" is a literal translation of the Sanskrit term "ahamkāra" which, not coincidentally but rather conveniently, draws on two enactivist (and Buddhist) concepts; the self as an ongoing process and the existence of the self as dependent upon a variety of causes and conditions. He elaborates, "the theoretical tool is the self-specifying system ---a collection of processes that mutually specify each other and thereby constitute the system as a self-perpetuating whole in relation to the wider environment."[343] [344] Furthermore, Thompson says "the implementation is a description of the self-specifying systems that constitute I-making at multiple levels (biological, psychological and social)."[345] Again, Thompson draws on the enactivist approach in which he and Varela argued that more complex scales emerged as organisms became more

[342] Ibid 326
[343] Ibid
[344] The self-specifying system was a concept developed by Varela, and Maturana and later elaborated by Varela Thompson and Rosch. The latter referred to a living single-celled organism as the prototype of a self-organising or autopoietic system in their book *The Embodied Mind* in which they developed enactivism.
[345]ibid

complex in their self-specifying processes. Here Thompson is using concepts and language of enactivism (e.g. complexity, self-specification and self-organisation, emergence) to analogize the development of self. Such elaboration is missing in the chapter 9 discussion of near-death and dying.

Finally, in chapter 10 in a section entitled "sense-making in precarious conditions" Thompson says:

> "Wherever there's a self, there is a world on which that self depends and to which it must relate by finding and creating meaning. Similarly, wherever there's a living being, there's an environment on which that being depends and to which it must relate by finding and creating sense. In short, living is sense-making in precarious conditions."[346]

Here Thompson is drawing on the concept of structural coupling, another concept used in enactivism. From the enactivist perspective, an autopoietic entity is said to be both structurally coupled with its environment and self-organising. By analogy, the self is both structurally coupled to the world in which it is embedded and self-organising. Had Thompson brought concepts such as the self-organising system, structural coupling and so on into the his chapter 9 he would have gone a long way toward integrating death into the enactive approach but he did not do so. I do this in the dissertation.

As with Thompson's discussion of the self in chapter 10, I too incorporate enactivist concepts in my discussion of death and dying. One concept within enactivism is the circular causality of biological, psychological, and environmental processes. The EDP conceives and discusses death and dying as interdependent biological, psychological, technological and cultural processes which dynamically evolve as these four components evolve. Dynamic Systems Theory may be applied to analyse these interdependencies. This is an original insight and is significantly different from Thompson's discussion of death and dying. While I don't think Thompson would disagree with much that I have formulated, he has not shown the self-organisational continuity of life and death in his discussion of death and dying.

I draw on interdependence of several scales throughout the dissertation and in the chapter on death and dying, I draw on artefactual and phenomenological cognitive technologies and mixed biological, psychological and social devices, to argue that there is mutual causality of biology, mind, technology and that may impact dying and death. For example, in section 7.5 of the dissertation entitled "Mind, Death, Technology and Dynamic

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[346]ibid 328

Systems", I show that death and dying are culturally defined, and dependent upon the dynamic development of artefactual cognitive technology and phenomenological cognitive technology. Unlike Thompson, I do not conceive the death meditation *only* as a form of ritualized phenomenology. Nor do I think of this meditation as a literal description of the process of dying. My view is that there is not enough data to draw an educated opinion of what is happening in the process. It is legitimate and useful to consider both the phenomenology of death and dying separately from the science of these processes. I do believe the claim is intriguing , if true, that the meditation masters heart region remains warm when he is declared dead from the medical perspective. Thus there is a need to research this phenomenon. I agree with Varela that the existence of subtle consciousness is an open question. In this regard Varela, Thompson and I are what I have referred to as presumptive naturalists. There are however wide gradations within this position and I for one am open to exploring the claims made by ITB without a fixed metaphysical presupposition. Accordingly, I next discuss where my own view of naturalism sits with respect to conceptions of naturalism discussed in chapter 8 of the dissertation.

9.2. Assumptive and Presumptive (Methodological) Naturalism

Chapter 8 of the dissertation introduced the idea that mind may play a significant role in the processes of death and dying. If the ITB claims are to be open to scientific examination (as I believe is required by the EDP) then a research programme should be pursued which investigates the ITB role of mind in the processes of dying and death. I suggested an experiment in which brain scans of ITB masters were recorded in Dzogchen meditation (pure awareness devoid of object), sleep yoga and thukdam (if possible). The ITB claim is that in each of these practices rigpa (the subtle nature of mind) is achieved and maintained. If this is so and if rigpa is the same in each of these practices (as ITB suggests) then brain scans might look similar or identical. The presupposition is that rigpa supervenes on brain function. This presumption would be disputed by ITB. Here we come to the issue of one's stance on presumptions and assumptions. The physicalist assumption, adopted by medical science, is that the person is nothing beyond the physical so when the person dies brain and body functions cease and physical deterioration commences unless modified by environmental conditions (such as cold temperature or dryness). ITB claims that the person is not only physical. In particular, ITB says that subtle mind continues to function after physical death. This claim might appear to be specious if not for the reports of credible witnesses that after physical death the heart region of an accomplished mediator remains warm for an extended period of time regardless of environmental conditions. The ITB claim is that subtle mind continues to reside in the region of the subtle or energetic heart. This position would appear, at first glance, to challenge the physicalist metaphysical assumption; or data might lead to an extension or elaboration of physicalism. I might speculate that if this phenomenon is shown to exist and if no explanation can be given based on what is already known to science, there are a few explanations.

One explanation is that enough is not known about the interdependence of mind and body; another explanation is that subtle energy is beyond the resolution of current instrumentation.   If the latter is the case, then it is possible then more sensitive technology would need to be developed. This is consistent with the "normal science" activity of the Physicalist paradigm. Another possibility is that no instrumentation would ever be able to register this subtle energy because it is not physical.   So ever increasing instrumental resolution would continue to search in vain for this subtle energy.   In all these cases, further scientific research and technological development would be necessary. Thus, the apparent anomaly might to be resolved by investigation. The assumptive naturalist is likely to conclude that this apparently anomalous data would be explained when more was understood about the manner in which brain and body interdependently functioned. The presumptive naturalist and my view is that this apparently anomalous data should initially be understood physically. However, an accumulation of anomalous data may require a modification or extension of the naturalist paradigm.

I suggest that if the experiment yields apparently anomalous data, an initial line of inquiry should be pursued to examine the possibility that advanced meditators are able to regulate metabolic functions. But I would not discount the possibility that this and other physicalist explanations might eventually fall short. In the case that anomalous data cannot be explained I would consider the possibility, as might Kuhn, that the paradigm of physicalism needs to be supplemented, extended or modified.

As I stated in chapter 8, metaphysical naturalism may stand as an impediment to the investigation of death and dying from a comparative, specifically ITB, perspective when it is akin to physicalism since the foundational assumption is that cognitive phenomena are physical only. This assumption tends to lead to narrowing research undertaken and interpreting data in such a manner that the possible immaterial or subtle nature of mind (from the ITB perspective) is not even considered.

In other words, the ITB practices or their conceptual scaffolding might not be deemed worthy of consideration or investigation. In defence of this position the metaphysical naturalist might argue, as does Mahner, that if the scientific method is to yield results that describe the world *as it truly is* then metaphysical naturalism must be assumed because it is a constitutive ontological principal of science.   According to him, the scientific method assumes the presuppositions of ontological realism and ontological lawfulness (among others). Any experiment consists of elements which actually exist in the world. And the ability to verify the results of an experiment by repeating it (assuming the experiment is performed properly each time) is based on ontological lawfulness.[347] I disagree with Mahner and agree with the enactivist view in this matter; the requirements of realism and lawfulness are consistent with *methodological* naturalism, and do not require the assumption of a stronger metaphysical view.

From the enactivist perspective, scientific methodology does not reveal the world as it is but rather reveals the world in relation to the methodology employed, the environmental context in which it is investigated and the perceptual capacities of humans. However, the EDP neither affirms nor denies metaphysical naturalism but affirms only methodological naturalism, holding in abeyance a metaphysical position (see 8.0). I conceive this forbearance as being open to the metaphysical position of mind's effect on the processes of death and dying. And I believe that the comparative examination of minds' impact on death and dying requires one to hold in abeyance the assumption of metaphysical naturalism while using the scientific method.

Varela's position regarding epistemic naturalism in relation to the existence of subtle consciousness is consistent the EDP. His view was to suspend judgment about the ontological status of subtle consciousness (a position I have referred to as "presumptive naturalism") and Thompson agrees with this position. Thompson says that staying with the open question means examining it without trying to force any particular answer. For him

[347] Mahner, Martin. (2011) The role of metaphysical naturalism in science *Science and Education* 21 1437-1459 DOI 10.1007/s11191-011-9421-9 retrieved 25/03/21

this requires an empirical approach in which experience is vital and judgment is suspended regarding speculative matters (such as metaphysical naturalism) falling outside what is available to experience.[348] Suspending judgment is in effect leaving open the question of the existence of rigpa and its causal efficacy pending evidence which either convincingly demonstrates or disproves its existence and causal efficacy. In either case, the metaphysical basis remains an open question. Abeyance (with regard to metaphysical naturalism) is a psychological and rational position in which the researcher presumes the usefulness of the scientific method (methodological naturalism) but does not presuppose a fixed metaphysical position which might perhaps prejudice the investigation of unusual ITB claims e.g. those concerning the physical death of the body but not its deterioration. This requires her to exercise forbearance and tolerance. Kuhn too acknowledged the importance of psychological factors in accepting or rejecting a particular paradigm.

> "Kuhn also emphasises the role of psychological and sociological factors in disposing scientists to adopt or reject a particular paradigm. …Every scientist is also influenced in how they see the world by who happens to be their teachers and students. So paradigms are the intellectual property of social groups whose rules and conventions are to be found not just in their textbooks and theories…"[349]

Presumptive naturalism can be contrasted with assumptive naturalism, a psychological and rational position in which metaphysical naturalism is assumed as the necessary and unchangeable philosophical foundation of research. Assumptive naturalism is methodologically similar to metaphysical naturalism in that a scientist or philosopher who has adopted assumptive naturalism may narrow the scope of research and avoid such research as the ITB notion of the subtle or immaterial nature of mind; so called "spooky" research is avoided. Of course, what "spooky" consists of is in part culturally defined and often not rigorously examined. The assumptive naturalist might claim that research investigating the subtle nature of mind is spooky if subtle or immaterial characteristics are attributed to mind. The presumptive naturalist would be more open to consider if, and in what manner, mind is subtle and how this might be investigated. The ITB position on mind might be considered spooky by some. But it is possible to interpret the ITB position on the relationship between mind and breath naturalistically. The ITB tradition has created the

[348] Thompson E (2015) xxiv-xxvi

[349] Ladyman James (2002) *Understanding the Philosophy of Science* London: Routledge 105

metaphor of the "wind horse". Physical mind is said to ride the breath as a rider rides a horse. The relationship between mind and breath is well understood scientifically.

The relationship of breath, body and mind has been scientifically investigated by researchers studying the effect of breath on body and mind in the practice of gTummo yoga. To date, data collected by researchers has been interpreted consistent with an implicit assumption of metaphysical naturalism or physicalism but this need not be so.[350] Instead, a presumptive naturalist could take no metaphysical position and continue to aggregate data through a variety of experiments either advancing no hypothesis until after she has seen what the data suggests (a la Kuhn) or advancing a hypothesis prior to obtaining data but being open to rejecting it if the data is inconsistent with it (as Popper suggests)

It is worth clarifying the ITB claim about the nature of mind since both immateriality and subtlety have been attributed to rigpa.[351] Importantly, "subtle" may be understood to be physical (not immaterial) in some sense although perhaps not in a manner currently recognized by science. The correct attribution is controversial even within ITB. For example, the Dalai Lama has opined that even the most subtle consciousness must have a neural correlate.[352] He has also, on several occasions, put forward the more traditional and majority ITB position that mind transcends neural function.[353] If indeed the mind is subtle (a view to which the EDP is sympathetic) then its neural correlates can perhaps be investigated.

The comparative approach that I suggest is not a common feature of the scientific method, and there may be significant resistance to it. I have subscribed to it in part because there is reason to believe that the ITB practices of dying and death can throw light on the role of mind in these processes. For example, the claim that the heart region remains warm for an extended period of time in advanced meditators during thukdam (see 7.1, 7.4, and 8.2.4) is an intriguing claim that should be examined in order to possibly throw light on the ability of mind to impact the dying process in a manner science currently cannot explain.

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[350] Benson H et. al. (1982); Kozhevnikov M, Elliot J, Shephard J , Gramann K (2013) Neurocognitive and Somatic Components of Temperature Increases during g-Tummo Meditation: Legend and Reality PLOS ONE 8(3) https://doi.org/10.1371/journal.pone0058244

[351] Technically, according to ITB, rigpa is said to be "most subtle". Mental activity such as thoughts and emotions are referred to as "subtle".

[352] Thompson (2015) xxii

[353] For example: Dalai Lama (2006) *The universe in a single atom* London: Abacus an imprint of Little Brown 117-118; Varela FJ (Ed) (1997) *Sleeping, dreaming, dying* Boston: Wisdom Publications 120-123

The philosophical foundation for such an investigation should be presumptive naturalism because the ITB claim of mind's subtlety or immateriality is not one which assumptive naturalists generally might be willing to consider. Or if considered, an assumptive naturalist might assume that anomalous data could be explained or will eventually be explainable by the current paradigm without the puzzle-solving of Kuhnian "normal science". However, according to the presumptive approach I suggest, it is presumed that there is or will be a scientific explanation for anomalous data within the current paradigm but there is scope to consider that such data may require modification of the paradigm. In other words, the presumptive naturalist permits what the assumptive naturalist assumes but also permits that genuinely anomalous data might force a paradigm shift. One might ask what I believe the experiment I have proposed in chapter 8 might show. Let's assume brain scan of the dead indicates neural activity and this constitutes anomalous data. As a presumptive naturalist, I might consider two possibilities; either that the data is considered anomalous because 'normal science' activity of medical science is not sufficiently advanced to explain it or if further anomalous data is accumulated, modification or shift in the physicalist paradigm is required. The is the position of the EDP.

9.3. Conclusion

Enactivism recognises that cognition is not merely a brain-bound phenomenon but rather necessitates a body situated in the world. That body, whether it is a single-celled organism or a human being, is organised to maintain homeostasis far from thermodynamic equilibrium. In humans, maintaining that homeostasis, in part, requires navigating the complex psycho-social environment. Apprehension is the brain-body-world tool that allows us to do this. Apprehension does not merely register the world "as it is" in the manner a camera takes pictures. Rather, it colours the world in a manner that, ideally, assists in maintaining that homeostasis. According to ITB, the colour with which apprehension paints the world is problematic on two counts. Firstly, virtually every human being divides self from other in a manner that fails to acknowledge the interdependence of self and other. This schism creates and proliferates suffering. ITB claims that this is a primordial, but temporary human condition which can be resolved. Secondly, since most of us are embedded in societies that misapprehend the interdependent nature of the self, we are also enculturated to maintain this illusion of self. The ITB claim is that this misapprehension of the nature of self ultimately leads to misapprehension of the nature of the mind which ITB says, is pure, unintentional awareness, an experience of unity, not separateness.

The open-minded and eco-dynamically minded cognitive researcher should explore the nature of the mind in both a transcultural and interdisciplinary manner. Toward this end, I have advocated presumptive (methodological) naturalism, an empirical and psychological approach which avoids a fixed metaphysical stance. Science is the best method to do this but ontological naturalism is a bias that can impede the open-minded, cross-cultural scientific study of the mind. The eco-dynamic paradigm draws on enactivism to a point but refines its naturalistic foundation, a foundation I have referred to as presumptive (methodological) naturalism, in a manner which requires an "open-minded" study of mind. And dynamic systems theory is an excellent method to model, analyse and explain the research findings of eco-dynamically minded (or any) cognitive scientist.

In this thesis, I have focused the eco-dynamic paradigm on the dying mind as a particular example of a more general adoption. It is in death and dying that enactivists and Indo-Tibetan Buddhists part company and furthermore, it is with regard to death and dying that anomalous data may appear if advanced ITB practitioners are able to demonstrate states of mind currently unknown in the West. Neurophenomenology is necessary to correlate the data from brain scans with phenomenological reports. However, this method is not available when studying the dying (and dead) mind. As I stated, it is the hypothesis of the eco-dynamic paradigm that states of mind achieved in *Dzogchen* meditation and sleep yoga are similar to or identical with the state of mind achieved in death meditation. Since the neurophenomenological method is available in *Dzogchen* meditation and sleep yoga, objective data from these scans may then be compared with those obtained during the death meditation.

As I said at the beginning of this dissertation, it is my hope that the hypothetical neuroscientists, who know all there is to know about the neural correlates and biochemical interactions of consciousness, will now be convinced that they must collaborate with other experts within the cognitive sciences to arrive at an eco-dynamic perspective on consciousness, and that they should begin cross-culturally to investigate the full potential of the mind.

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